

THE BOTANICAL MAGAZINE

PUBLISHED
BY
THE BOTANICAL SOCIETY OF JAPAN

Volume 70

Nos. 823-834

TOKYO

1957

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Developmental Mechanics of Fucaceous Algae II. Vital Staining of Centrifuged *Coccophora* Eggs

by Singo NAKAZAWA*

中沢信午*: フークス科藻類の発生力学 II. 遠心分離したスギモクの卵の生体染色

Received June 15, 1956

As a result of the writer's previous experiments of vital staining⁽⁸⁾ and differential susceptibility^(9, 10) for toxic substances on *Coccophora* and *Sargassum* eggs, it was known that when the morphological polarity was determined after fertilization the permeability for various matters increased partially on the side where the future rhizoids were to be formed, while it was uniform on all sides of the egg till the appearance of the morphological polarity. However, it is still questioned whether or not the polar staining and the polar susceptibility are attributed to the polar distribution of some intracellular materials having special affinity to those dyes or those toxic drugs, rather than to the differential permeability. This point will be clarified if the polarity determined eggs are centrifuged to stratify the intracellular materials in various directions to the morphological polarity axis, and then stained vitally with those dyes used in preceding experiments. That is, in such an experiment, if the staining also appears at first in the rhizoid pole selectively independently of the stratification, the conclusion of the preceding experiments will be verified. But if the staining appears restricted to a certain stratum resulted with the centrifuging, it will be more probable that the polar staining is attributed to a certain intracellular material.

In April 1956, *Coccophora Langsdorfii* was collected at Asamushi, and cultured in glass vessels. Eggs discharged were artificially fertilized, and used for the experiment. Those eggs in which the morphological polarity was determined with transformation from spherical into ovate form, were centrifuged together with eggs of the younger stage still undetermined. An electric centrifuge of 30 cm in diameter was turned in the experiment in a speed of 3000 cycles per minute, i. e. 1500 times gravity, for 20 minutes. The centrifuged eggs were taken out from the centrifuging tube and stained vitally with Bismarck brown, brilliant green, and with neutral red. The staining media were prepared in the same way as those in preceding experiments.

A clear stratification was resulted with the centrifuging. The order of stratifi-

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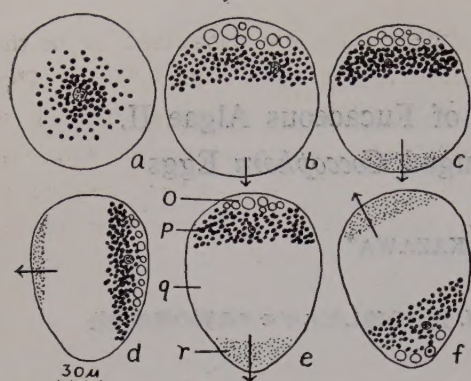


Fig. 1. Fertilized *Coccophora* eggs, polarity determined (d~f), undetermined (a~c). a) Uncentrifuged, b) centrifuged, c~f) stained with Bismark brown after centrifuged. Note that the staining appears selectively on the centrifugal side independent of the polarity. o, Oil layer; p, plastid layer; q, plasm layer; r, granule layer; and the arrow indicates the centrifugal direction. Staining is dotted.

ing with Bismarck brown is not related to the polar permeability but it is based merely on the stratification of the stainable granules.

Staining appears differently with brilliant green or with neutral red. Eggs centrifuged before the morphological polarity was determined, stained uniformly from all over the surface with those dyes in spite of the stratification, showing undifferentiation of the permeability and that what was stainable was not a special material

stratified in the cell. In those eggs, however, in which the morphological polarity has been determined, the staining begins to appear partially on the pointed side where the rhizoids are to be formed in a later stage, without relation to the stratification (Fig. 2). The staining spreads in time towards the opposite side till the whole stains uniformly.

It was pointed out in preceding papers^(6, 7) that the polarity determination in eggs of *Coccophora* and *Sargassum* was independent of the arrangement of the intracellular materials but is dependent upon some cortical differentiation. This interpretation is in accordance with some instances presented

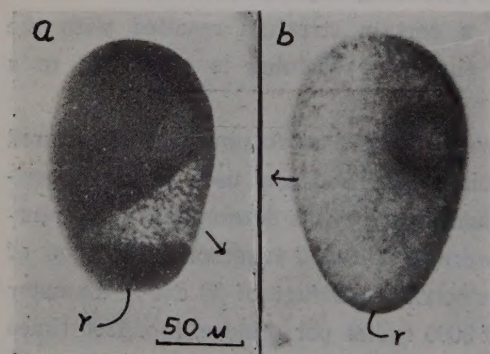


Fig. 2. Vital staining of the polarity determined *Coccophora* eggs with neutral red, after being centrifuged. a) Centrifuged obliquely, and b) laterally. Note the polar staining independent of the centrifuging axis, but dependent upon the polarity, appearing highest in the rhizoid pole (r). Arrow indicates the centrifugal direction.

in zoological fields^(1,2,3,4,5,13,14). The cortical differentiation was considered to be the induction of a gradient of permeability, highest in the rhizoid pole^(8,9,10,11,12). This supposition is verified by the above experiments. That is, the polar staining is not dependent upon the axis of the stratification, but is connected with the morphological polarity. This polar permeability seems to be closely in relation to the morphogenetic movement of the fertilized egg, considering the polarity axis is also determined with a forced transformation^(6,15).

Summary

(1) Fertilized eggs of *Coccophora Langsdorfii* were centrifuged with 1500 times gravity for 20 minutes. As a result, the intracellular materials were stratified into four layers: oil drops in the centripetal edge, plastids with nucleus, clear plasm layer, and then the granule layer in the centrifugal end.

(2) The granule layer is composed of microsome-like granules specially stainable with Bismarck brown.

(3) Polar staining, with brilliant green or with neutral red, begins to appear in the rhizoid pole after the morphological polarity is determined, while the staining appears uniformly on all over the surface before that stage. The mode of this staining is independent of the axis of the stratification. This phenomenon verifies that the permeability for these dyes is the highest in the rhizoid pole.

The present writer is grateful to Prof. Dr. Arika Kimura, Tohoku University, for his kind support of this investigation.

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A Cytotaxonomical Study on *Anemone Hepatica* L. (Ranunculaceae) of Japan

by Minosuke HIROE*

広江美之助: 日本産ミスミソウ群の細胞分類学的研究

Received August 7, 1956

Anemone Hepatica L. of Japan has been divided into var. *japonica* (Nakai) Ohwi (the lobes of the leaves acute) and f. *nipponica* (Nakai) Ohwi (the lobes of the leaves rounded or obtuse).

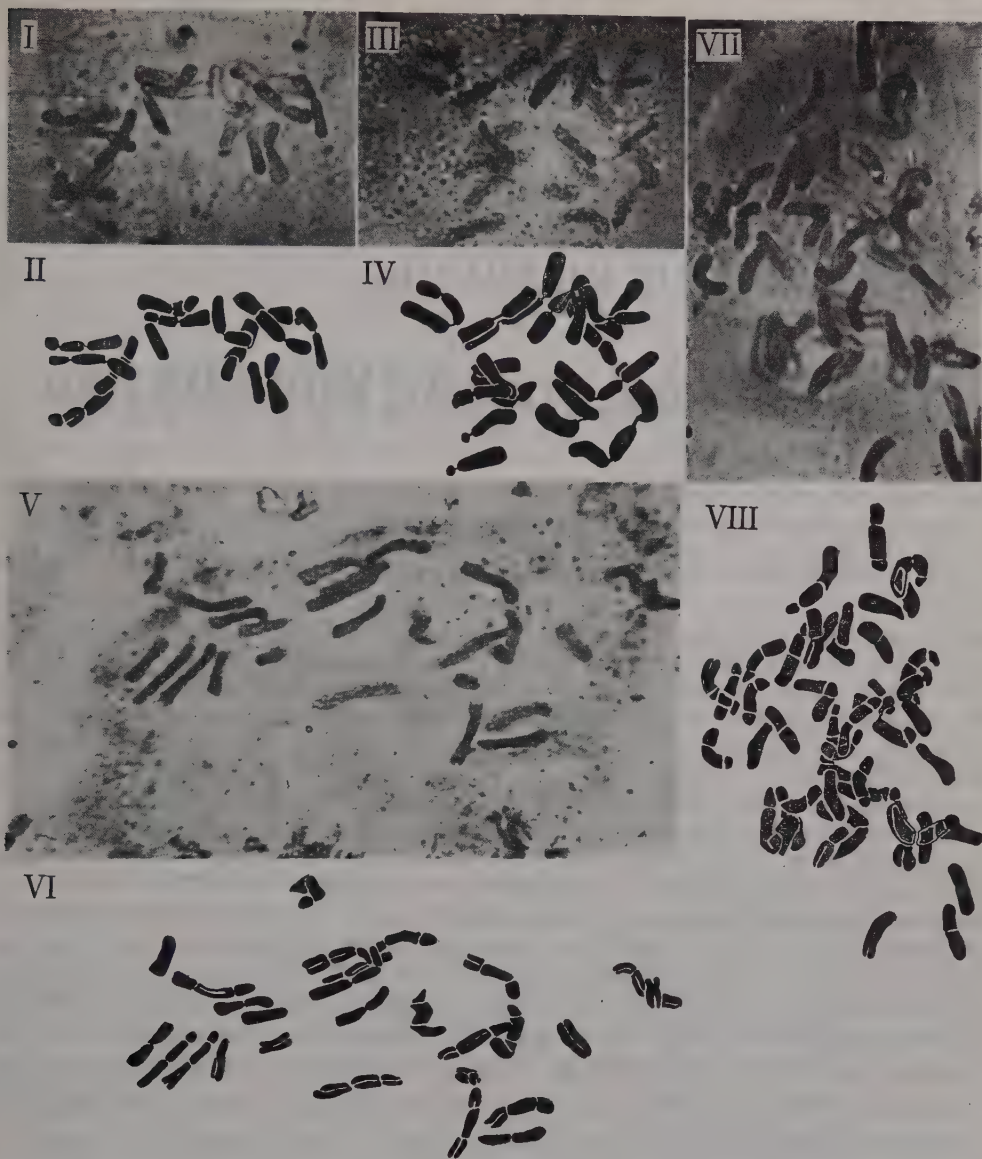
The chromosome number of var. *japonica*, determined by G. Nakajima¹⁾ and M. Kurita²⁾, was $2n=14$. In the present study, cytological observations are made on the root-tip cells of var. *japonica* f. *japonica* (plants collected at Mt. Asama, Prov. Ise), f. *magna* (plants collected at Mt. Kawachi, Nishitagawa, Prov. Uzen), var. *nipponica* (plants collected at Mt. Fujiwara, Prov. Ise) and var. *pubescens* (plants collected at Mt. Fujiwara, Prov. Ise). The chromosome number varied as follows: in var. *japonica*, $2n=14$, $x=7$ (Figs. I-IV, IX-X), and in var. *nipponica*, $2n=28$, $x=7$ (Figs. V-VI, XI) and in var. *pubescens* $2n=42$, $x=7$ (Figs. VII-VIII, XII). Namely, a polyploid series with a basic number 7 was found. The karyotype of these three varieties, however, differed slightly, i. e. that of *japonica* was $K(2n)=14=8^{SM}+4^{BSM}+2C$; var. *nipponica*, $K(2n)=28=16^{ASM}+4^{BSM}+8C$; var. *pubescens*, $K(2n)=42=24^{ASM}+6^{BSM}+12C$. In the $2n=14$ group of var. *japonica*, two karyotypes were observed in two formes, i. e. in f. *japonica* the smallest chromosome had no clear constriction (Figs. I-II, IX, 7), while in f. *magna* the smallest had a subterminal constriction (Figs. III-IV, X, 7).

F. *magna* grows taller than f. *japonica* and has larger leaves than those of f. *japonica*. The length of stomata on the abaxial surface of the leaves of f. *magna* is longer than that of f. *japonica*, and the number of chloroplasts in the guard cell of the former is also more numerous than that of the latter. F. *magna* is distributed from Central Honshu to North Honshu, while f. *japonica* from Kyusyu through Shikoku to Central Honshu. In var. *japonica* ($2x$), var. *nipponica* ($4x$) and var. *pubescens* ($6x$), the size of stomata and the number of chloroplasts in the guard cell seem to increase (proportionally) in direct proportion to the polyploidy.**

From the fact that var. *japonica*, var. *nipponica* and var. *pubescens* are closely related each other in the morphological characters as well as in the karyotypes, it may be concluded that they belong to a single species.

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** Measurements of stomata length and of chloroplast number are made with three leaves in each variety, and ten stomata in each leaf.



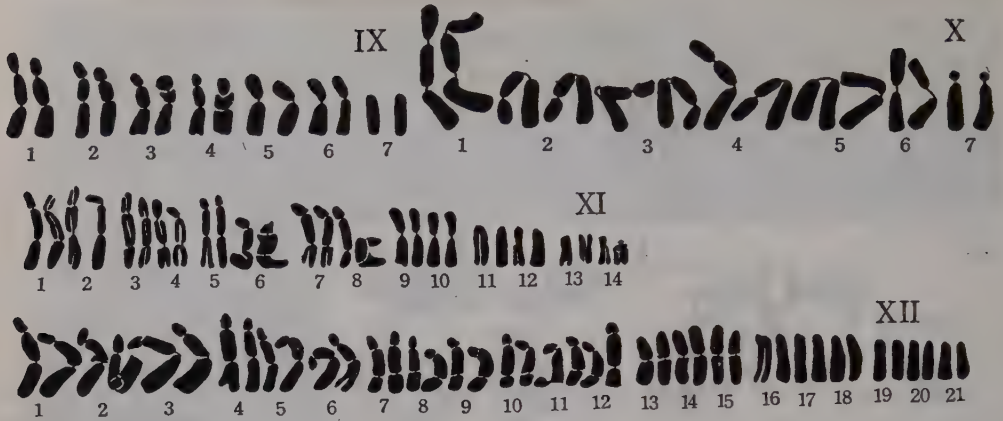
Figs. I-XII, metaphase chromosomes in root-tip cells of *Anemone Hepatica* L. var. *japonica* (Nakai) Ohwi f. *japonica*, f. *magna*, var. *nipponica* (Nakai) Hiroe and var. *pubescens* Hiroe. Photomicrographs are taken with a Homg. imm. $\times 100$ (n. A. 1.25) and Zeiss oc. $\times 10$, $\times 1250$ (pretreated with 8-hydroxyquinoline and stained with aceto-orsein).

Figs. I-II, somatic chromosomes ($2n=14$) of *A. Hepatica* L. var. *japonica* f. *japonica*. Fig. I, photomicrograph of metaphase plate. Fig. II, schematical reproduction of Fig. I.

Figs. III-IV, somatic chromosomes ($2n=14$) of *A. Hepatica* L. var. *japonica* f. *magna*. Fig. III, photomicrograph of metaphase plate. Fig. IV, schematical reproduction of Fig. III.

Figs. V-VI, somatic chromosomes ($2n=28$) of *A. Hepatica* L. var. *nipponica* (Nakai) Hiroe. Fig. V, photomicrograph of metaphase plate. Fig. VI, schematical reproduction of Fig. V.

Figs. VII-VIII, somatic chromosomes ($2n=42$) of *A. Hepatica* L. var. *pubescens* Hiroe. Fig. VII, photomicrograph of metaphase plate. Fig. VIII, schematical reproduction of Fig. VII.

Fig. IX, chromosome ideogram of *A. Hepatica* var. *japonica* f. *japonica*.Fig. X, chromosome ideogram of *A. Hepatica* var. *japonica* f. *magna*.Fig. XI, chromosome ideogram of *A. Hepatica* var. *nipponica*.Fig. XII, chromosome ideogram of *A. Hepatica* var. *pubescens*.

Lobes of leaves, acute. The number of chromosomes is $2n=14$*A. Hepatica* var. *japonica*.

Slender, 8-18 cm high. Leaves 2-3 cm long, 2-5 cm broad; average length of stomata on the abaxial surface of leaves 0.22 mm (0.20-0.24 mm); average number of chloroplasts in the guard cells 32 (24-40). The smallest chromosome has no clear constriction (Figs. I-II, IX).....f. *japonica*.

Plants 10-20 cm high. Leaves 3-6 cm long, 5-10 cm broad; the average length of stomata on the abaxial surface of leaves 0.25 mm (0.21-28 mm); the average number of chloroplasts in the guard cells 38 (30-48). The smallest chromosome has a sharp subterminal constriction (Figs. III-IV, X).....f. *magna*.

Lobes of leaves rounded or obtuse. The number of chromosomes is $2n=28, 42$.

The adaxial surface of leaves glabrate, the average length of stomata on the abaxial surface of leaves 0.24 mm (0.22-0.26 mm); the average number of chloroplasts in the guard cells 42 (34-52). The number of chromosomes $2n=28$ (Figs. V-VI, XI).....var. *nipponica*.

The adaxial surface of the leaves pubescent, the average length of stomata on the abaxial surface of leaves 0.32 mm (0.30-0.34 mm); the average number of chloroplasts in the guard cells 48 (38-56). The number of chromosomes $2n=42$ (Figs. VII-VIII, XII).....

.....var. *pubescens*.

Anemone Hepatica L., Sp. Pl. 538. 1753.

var. *japonica* (Nakai) Ohwi, Fl. Jap. 518. 1953. Syn. *Hepatica nobilis* Schreb.

var. *japonica* Nakai, Journ. Jap. Bot. 13: 307. 1937.

f. *japonica* Nom. Jap. *Misumi-so*.

Petiole 8-18 cm. longi; laminae foliorum supra glabellae subtus pilosellae, ad medium aequaliter trilobatae, lobis latissime ovatis, alii acutis; laminae adultae ex apice petioli ad apicem 2-3 cm longae 2-5 cm latae. Involucrum phylla 3, 5-10 mm longa 3-4 mm lata obtusa vel acuta sericea. Sepala 7-11 lineari-oblonga 5-8 mm longa 2-4 mm lata. Stamina numerosa 2-5 mm longa glabra.

Distribution: From Kyusyu through Shikoku to the central districts of Honshu. The karyotype of this forma may be depicted as follows:

$$K(2n)=14=8A^{SM}+4B^{SM}+2C$$

f. *magna* Hiroe, f. nov. Nom. Jap. *Ohmisumi-so*.

Petoli 10-20 cm longi; laminae foliorum supra glabellae subtus pilosellae, ad medium aequaliter trilobatae, lobis latissimime ovatis, alii acutis; laminae adultae ex apice petioli ad apicem 3-6 cm longae 5-10 cm latae. Involucri phylla 3, 5-10 mm longa 3-5 mm lata obtusa vel acuta sericea. Sepala 9-11 lineari-oblonga 7-12 mm longa 3-5 mm lata. Stamina 3-6 mm longa glabra. Ovaria sericea.

Type. Mt. Kawachi, Nishi-tagawa-gun, Prov. Uzen (S. Murai, June 10, 1934—in Herb. Kyoto Univ.). Distribution: From Central Honshu to Northern Honshu.

The karyotype of this forma may be depicted as follows:

$$K(2n)=14=8A^{SM}+4B^{SM}+2C^{St}$$

var. *nipponica* (Nakai) Hiroe, comb. nov. *Hepatica nobilis* Schreb. var. *japonica* Nakai f. *typica* Nakai, l. c. 13: 306, in clave. 1937; *Anemone Hepatica* L. var. *japonica* (Nakai) Ohwi f. *nipponica* (Nakai) Ohwi, l. c. 518. 1953. Nom. Jap. *Suhama-so*.

Petoli 10-25 cm longi; laminae foliorum supra glabellae subtus pilosellae, ad medium aequaliter trilobatae, lobis latissimime ovatis, alii obtusiusculis; laminae adultae ex apice petioli ad apicem 2-4 cm longae 3-8 cm latae. Involucri phylla 3, 8-15 mm longa 3-7 mm lata obtusa sericea. Sepala 6-8 lineari-oblonga 7-15 mm longa 3-7 mm lata. Stamina numerosa 3-7 mm longa glabra.

Distribution: From Western Honshu to North Honshu. The chromosome number of this variety is double (4x, Fig. XI) of that of f. *japonica* (2x, Fig. IX).

The karyotype of this variety may be depicted as follows:

$$K(2n)=28=16A^{SM}+4B^{SM}+8C$$

var. *pubescens* Hiroe, var. nov. Nom. Jap. *Ke-suhama-so*.

Petoli 5-12 cm longi; laminae foliorum supra pubescentes subtus pilosellae, ad medium aequaliter trilobatae, lobis latissimime ovatis, alii obtusiusculis; laminae adultae ex apice petioli ad apicem 1-3 cm longae 2.5-5 cm latae. Involucri phylla 3, 5-8 mm longa 3-5 mm lata obtusa sericea. Sepala 6-8 linearioblonga 5-13 mm longa 3-5 mm lata. Stamina numerosa 2-4 mm longa glabra. Ovaria sericea.

Type. Mt. Fujiwara, Prov. Ise (Z. Tashiro, Apr. 3, 1937—in Herb. Kyoto Univ.).

Distribution: From Central Honshu through Western Honshu to Shikoku.

The chromosome number of this variety is three times (6x, Fig. XII) of that of f. *japonica* (2x, Fig. IX). The karyotype of this variety may be depicted as follows:

$$K(2n)=42=24A^{SM}+6B^{SM}+12C$$

The writer expresses his cordial thanks to Prof. M. Shigenaga for his guidance in the cytological technique.

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Notes on some grasses III

by Tuguo TATEOKA*

館岡亜緒* イネ科雑記, III

Received August 15, 1956

5. Affinities of the genus *Brylkinia*.—*Brylkinia* is a monotypic genus including *B. schmidtii* Ohwi (= *B. caudata* Fr. Schm.) which inhabits Japan, Saghalin, South Kurile Islands and Manchuria. Bentham (1881) and Hackel (1887) placed it near *Pleuropogon* and *Uniola* which were assigned to Festuceae-Festucinae. Pilger (1954) transferred *Pleuropogon* to Festuceae-Glyceriinae, and retained *Brylkinia* in Festucinae. Ohwi (1942) proposed to treat *Brylkinia* as an independent subtribe, Brylkininae in the Meliceae. The characteristics of chromosomes and leaf structure of *B. schmidtii* have never been studied. In the present paper the results of their investigation and also considerations on the affinities of the genus are presented.

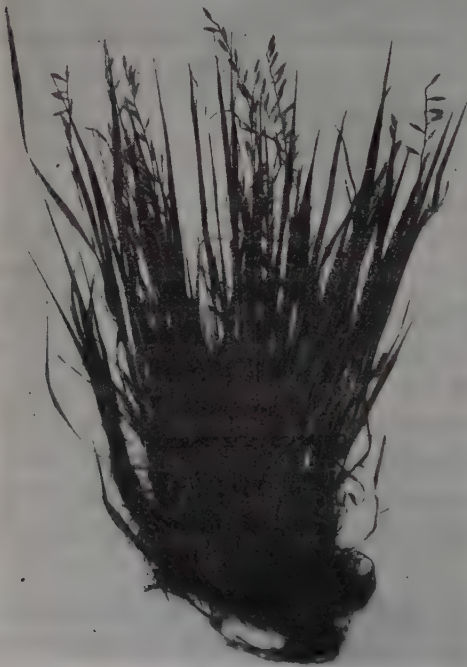


Fig. 1. *Brylkinia schmidtii* Ohwi

Chromosomes¹⁾—Materials for chromosome observation were collected at Mt. Mitsutôge, Yamanashi Pref., and Mt. Yatsu and Kamikôchi, Nagano Pref. Invariably in root tip cells forty small chromosomes were found. One pair of Sat-chromosomes was observed (Fig. 1, 2). The basic chromosome number is assumed to be ten.

Leaf structure—No bicellular hairs could be found either in the upper or lower epidermis. Siliceous cells show a rectangular shape and wavy contours (Fig. 2, III). In the upper epidermis unicellular hairs are found; they do not possess a sheath of epidermal cells at the base. A mechanical cell layer surrounds the vascular bundles, and the chlorophyll tissue is uniformly distributed between the bundles (Fig. 2, II). This clearly

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¹⁾ The method of chromosome observation was as follows. Root tips were directly fixed at the habitats in Navashin solution. They were later dehydrated, embedded in paraffin and cut at 15 micra. Gentian violet method was used for staining. Chromosome figures were drawn with the aid of an Abbe drawing apparatus.

shows that the characteristics of leaf structure of *B. schmidtii* fall into the Festucoid type.

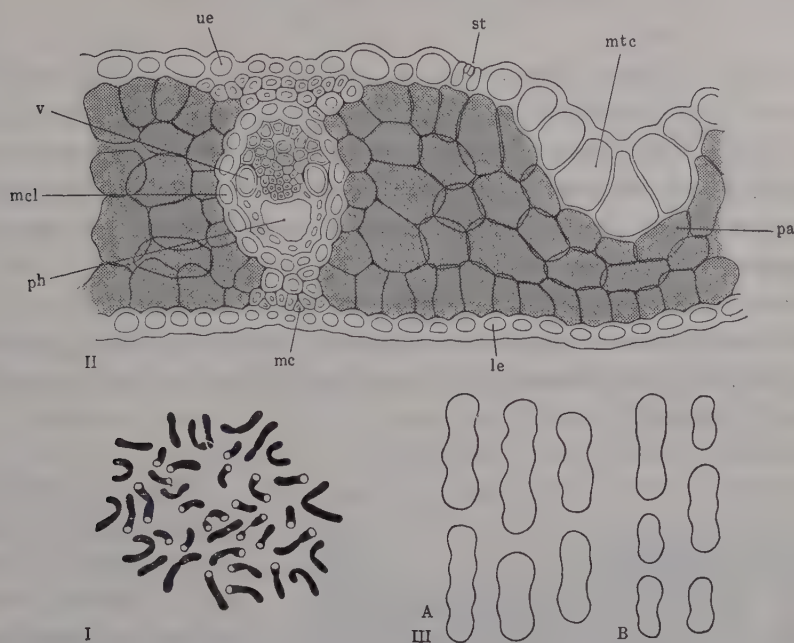


Fig. 2. *Brylkinia schmidtii* Ohwi. I. Somatic chromosomes $\times 2000$. $2n = 40$. II. Transverse leaf section $\times 300$. le-lower epidermis. mc-mechanical cell. mcl-mechanical cell layer. mtc-motor cell. pa-parenchyma. ph-phloem. st-stoma. ue-upper epidermis. v-vessel. III. Siliceous cell $\times 600$. A-upper epidermis, B-lower epidermis.

Consideration—Concerning the chromosome number and their size, *B. schmidtii* is evidently different from typical members of Festuceae-Festucinae. The latter has the basic chromosome number of seven and large (\sim medium) sized chromosomes, while *Brylkinia* is characterized by small chromosomes of basic ten. *Brylkinia* and *Uniola* which are erroneously placed in Festuceae-Festucinae have several characteristics in common such as a reduced lower floret, a compressed spikelet, many-nerved and winged lemma, etc. However, the two genera are obviously different in the characteristics of chromosomes, leaf structure and endosperm starch. *Brylkinia* has $b = 10$, while *Uniola* has $b = 12$; characteristics of leaf structure of *Brylkinia* are festucoid, but those of *Uniola* are panicoid; starch grains of endosperm of *Brylkinia* are compound, while those of *Uniola* are large, round, and simple. Considering these differences, the two genera cannot be closely related. As mentioned above, Ohwi (1942) included *Brylkinia* in Meliceae as an independent subtribe. Meliceae, according to Ohwi (l. c.) contains the genus *Glyceria*, but *Melica* and *Glyceria* should be separated having different chromosome characteristics. Chromosome number and size of *Glyceria* are in good accord with those of *Brylkinia*;

b=10 and small size. Also Festucoid type of leaf structure and compound endosperm starch grains are the same in the two genera. It seems to be correct that *Brylkinia* occupies an intermediate position between *Glyceria* and *Uniola*.

6. Systematic problem of the genus *Diarrhena*.—The genus *Diarrhena* includes a few species which are distributed in East Asia and one American species, *D. americana* Beauv. Two closely related species, *D. japonica* Franch. et Sav. and *D. fauriei* (Hack.) Ohwi are found in Japan. Chromosomes of *Diarrhena* have not been examined up to the present. The characteristics of them and leaf structure are reported below for the Japanese species.

Chromosomes—*D. japonica* was collected at Yugashima, Izu Penninsula, Shizuoka Pref., and *D. fauriei* was obtained from Nagawado (near Kamikôchi), Nagano Pref. In both species, thirty eight small chromosomes were found in root tip cells (Fig. 3, IA, IIA).

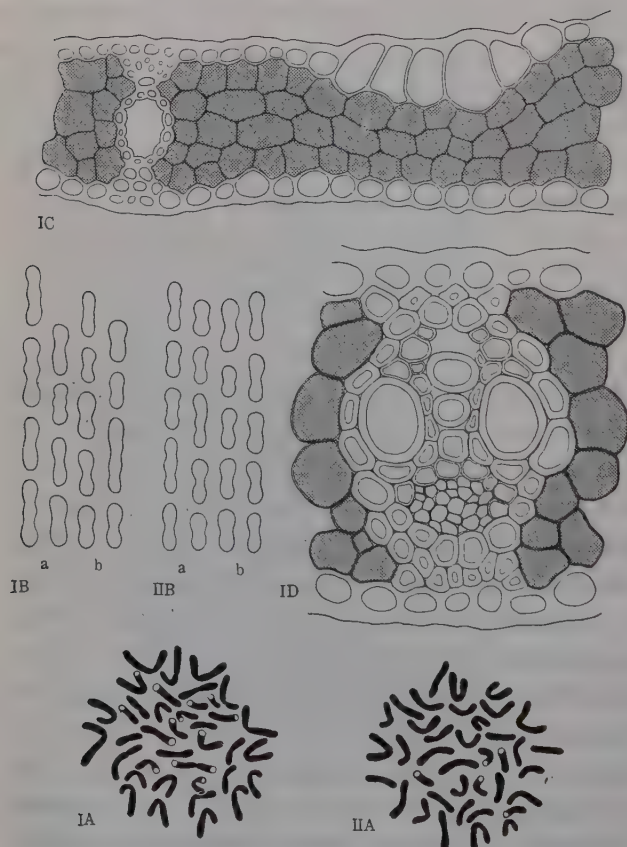


Fig. 3. I. *Diarrhena japonica* Franch. et Sav. II. *D. fauriei* Ohwi A. Somatic chromosomes $\times 2000$. I and II $2n = 38$. B. Siliceous cells $\times 300$. a—upper epidermis, b—lower epidermis. C, D. Transverse leaf section C $\times 300$, D $\times 375$.

Leaf structure—In the epidermis of the two species no bicellular hairs were found. Siliceous cells are of rectangular shape and wavy contours, giving a dumbbell appearance to short cells (Fig. 3, IB, IIB). In transverse leaf section, a mechanical cell layer surrounds the vascular bundles and chloroplasts are uniformly distributed throughout the mesophyll (Fig. 3, IC, ID). In respect to the shape of siliceous cells, *Diarrhena* is intermediate between the Festucoid and the Panicoid type. But, on the whole, the characteristics of leaf structure of *Diarrhena* may be regarded as those of Festucoid type.

The systematic placing of *Diarrhena* is very confused. Benthams (1881) included this

genus in Festuceae-Melicinae, and remarked that *Diarrhena* was a very closely related genus to *Melica* but different from it in the three-nerved and hardened lemma, large grains and two or one stamens. Bentham's view was followed by Hackel (1887). Hitchcock (1935) assigned *Diarrhena* to Festuceae, but placed it near *Molinia*, not *Melica*. Pilger (1954) ascribed *Molinia* to Arundineae and *Diarrhena* to Festuceae-Festucinae. Ohwi (1941) pointed out the following common characteristics in *Diarrhena* and *Phaenosperma*: lemma three-nerved, glabrous except for the nerves, awnless, rather firm; glumes and lemma involute in immature spikelets; grains large. In addition to the two genera, *Molinia*, *Moliniopsis* and *Hakonechloa* were included in Phaenospermeae by Ohwi (1942). He divided phaenospermeae in three subtribes; Phaenosperminae-*Phaenosperma* Diarrheninae-*Diarrhena*, Moliniinae-*Molinia*, a. o.

The basic chromosome number of *Diarrhena* is uncertain. The chromosome number of $2n=38$ found in *D. japonica* and *D. fauriei* is very unusual in grasses. As basic numbers, 5(10), 6(12), 7, 8, 9 and 11 occur in Poaceae. The number of thirty eight in the two species is assumed to have been produced *secondarily* from one of the basic numbers indicated above. The small *Diarrhena* chromosomes are different from the large chromosomes found in typical members of Festucinae. The chromosomes of *Poa* are somewhat shorter and narrower than those of typical

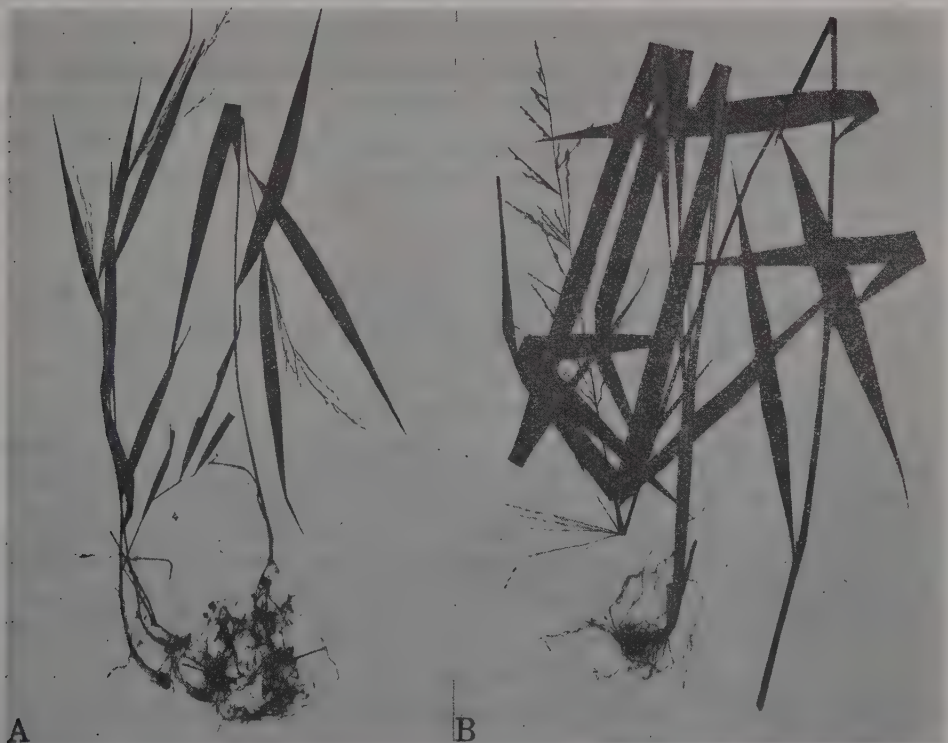


Fig. 4. A. *Diarrhena japonica* Franch. et Sav. B. *Phaenosperma globosum* Munro

members of Festucinae showing a similarity to *Diarrhena* chromosomes, but *Poa* is characterized by the basic number of seven. The chromosomes of *Melica* are somewhat larger and wider than those of *Diarrhena*. Agrostaceae, Phalarideae, Triticeae, Festuceae, etc. which have large (~medium) chromosomes and seven as basic number and a leaf structure of Festucoid type have the center of distribution in the Mediterranean region (cf. Tateoka 1956a, 1956b, 1956c), 1956d, 1956e). The present author is of the opinion that these tribes have a monophyletic origin, and established for them the group Eu-festuciformes. Although *Diarrhena* is festucoid in leaf structure, this genus cannot be included in Eu-festuciformes group. Because not only distinctive features of external morphology, such as 3-nerved lemma, large beaked grain, 2 opposite stamens, but also the small size of chromosomes are in disagreement with the characteristics of the Eu-festuciformes group. Moreover, the distribution of *Diarrhena* species does not coincide with that of Eu-festuciformes group. Therefore, it is reasonable to separate *Diarrhena* from Festuceae.

The characteristics of leaf structure in Molinieae are different from those of *Diarrhena* showing threadlike bicellular hairs and an outer bundle sheath which does not contain chloroplasts surrounding the vascular bundles (cf. Tateoka 1956f). In spite of such differences, *Diarrhena* and Molinieae have some characteristics in common; the uniform distribution of chlorophyll tissue, small chromosome size, 3-nerved lemma, etc. *Phaenosperma* and *Diarrhena* share several common characteristics concerning external morphology (cf. Ohwi 1941) and also festucoid leaf structure and the small size of chromosomes. But *Phaenosperma* has some peculiar characteristics in external morphology; 3-lodicules, glumes adhered at the base, leaf blades with petiole-like base found at the base of the culms. Thus, these genera show several points of similarity as well as difference. They seem to be not directly but remotely allied.

I wish to express my cordial thanks to Dr. J. Ohwi and Dr. Y. Takenaka for their valuable helps during the course of the present investigation.

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Effect of Ringing and Incision Given to the Stem on the Transmission of Photoperiodic Stimulus in *Pharbitis Nil*

Shun-ichiro IMAMURA* and Atsushi TAKIMOTO*

今村駿一郎*・滝本 敦*: アサガオの日長刺激伝達に及ぼす茎の輪截及び切込の影響

Received August 29, 1956

It has been reported in *Xanthium* and *Perilla* that the transmission of photoperiodic stimulus is inhibited by girdling or ringing given to the stem between the donor leaf and the receptor bud (1, 2, 6). From this fact, besides others, it appeared probable that the phloem was the tissue of transmission of photoperiodic stimulus. Therefore it was desirable to get more information on the effect of ringing and incisions upon the flowering response in other plants. The present paper deals with experiments regarding this point with *Pharbitis Nil*. The material used was the same as in previous papers (3, 4).

Transmission across the ringed stem. When the plants grown under continuous illumination developed three fully expanded leaves, the main axes were removed above the third node. The cotyledons and the first leaf, and their axillary buds, were removed. The stem between the second and third leaf was ringed, and then one of the leaves was given 8 hour short day treatment for three days by use of light-proof bags, while the other leaf was left exposed to continuous illumination.

Ringing was done by constantan wire which was looped around the stem and heated by electric current. By this operation all the living cells in the operated zone are killed, and after a day or so they change their color to brown, but the vessels of the stem continue to function normally or apparently so, supplying water to the upper portion of the stem and thus enable the upper part to remain alive and to develop axillary buds. After about ten days, however, gradually the buds begin to wilt. Control plants were not ringed and the second or third leaf was given short day treatments in the same manner as in the experimental lot. The light control lot was continuously exposed to light. About ten days after the treatment, the third node of the ringed plants was cut off and its lateral shoot which showed an indication of wilting was examined. After further ten days or so the third lateral shoot of control plants was examined, and the third node was removed

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to force the axillary bud of the second node to develop. Flower initiation on the second lateral shoot in both experimental and control lots was examined about two weeks after the removal of the third node. The experiments were several times repeated and all showed similar results. The results of one experiment are shown in Table 1. All plants without ringing initiated flower primordia on the lateral

Table 1. Transmission of photoperiodic stimulus across the ringed stem of *Pharbitis Nil*.

(Sown on May 25, treatment started on July 2, 1951)

Treatment	Leaf exposed to short days	No. of plants observed	No. of plants with flower primordia on axillary shoot of the		No. of flower primordia on axillary shoot of the		Average number of flower primordia per plant	
			2nd node	3rd node	2nd node	3rd node	2nd node	3rd node
Stems between 2nd and 3rd nodes were ringed	2nd leaf	50	47	0*	272	0*	5.5 ± 0.30	0*
	3rd leaf	50	0	48*	0	160*	0	$3.2 \pm 0.18^*$
No ringing	2nd leaf	29	29	27**	51	222**	1.8 ± 0.27	$7.7 \pm 0.31^{**}$
	3rd leaf	29	25	29**	56	230**	1.9 ± 0.19	$7.9 \pm 0.24^{**}$
	Light control	20	0	0**	0	0**	0	0**

* Observed on July 14.

** Observed on July 23.

Other observations were made on August 9.

buds of the donor leaf. In 27 out of 29 plants, whose second leaf was the donor, and in 25 out of 29 plants, whose third leaf was the donor, the stimulus received by the donor leaf was transmitted to the lateral shoot of the adjacent node causing flower initiation. But when the stem between the two nodes was ringed, the lateral buds failed to initiate flower primordia in so far as they were separated from the treated leaf by ringing, irrespective of the position of the leaves.

Table 1 shows that the number of flower primordia on the third bud in a ringed plant is less than in the control plants. As the buds above the ringed parts begin to die after about 10 days, the observations must be made early before the response manifests itself completely at the growing point. Therefore the number of flower primordia observed is considerably less than could have been expected when the bud would have developed normally.

The experiment shows clearly that the photoperiodic stimulus can be transferred up and down the stem but not across the ringed part in *Pharbitis Nil* as reported for *Xanthium* and *Perilla* (1, 2, 6).

It is also remarkable that, in control lots, the number of flower buds initiated on the lateral shoot of the second node is far less than that on the shoot of the third node, whichever leaf was exposed to short day. The following facts may be given as a reason for this. The axillary bud of the third node begins to develop

immediately upon removal of the main axis whereas that of the second node remains dormant or apparently so before the third node is removed. Thus at the time of dark treatment the upper bud predominates over the lower one in its developmental rate and, in addition, the reactivity of the former is higher than that of the latter. In the lot in which the second bud was separated from the third by ringing, the former bud produced a relatively large number of flower primordia as compared with that of the non-ringed plant.

Transmission through the incised stem. Plants were deprived of the main axes above the fourth node, all leaves and buds were removed to the third leaf and the fourth bud. One lot of these plants were given several incisions on two opposite flanks of the stems between the third and fourth nodes. Another lot without incisions served as control. Then the plants were exposed to a 21 hour dark period. Flowering responses on the fourth axillary bud are represented in Table 2 (Exp. 1). In the

Table 2. Transmission of photoperiodic stimulus across the incised stem of *Pharbitis Nil*.

	Treatment	Duration of dark period in hours	No. of plants observed	No. of plants with flower primordia	No. of flower primordia	Average number of flower primordia per plant
Exp. I*	Stems were incised between the 3rd and 4th node.	21	19	16	83	4.4±0.70
	No incisions.	—	20	20	136	6.8±0.72
Exp. II**	Stems were incised between the 3rd and 4th node.	16	17	2	5	0.3±0.24
	No incisions.	—	22	22	88	4.0±0.53

* Sown on May 21, treatment started on June 23, dissected on July 14, 1950.

** Sown on September 18, treatment started on October 9, dissected on November 9, 1955.

control lot, all plants, and in the experimental lot, 16 out of 19 plants initiated flower primordia. The number of flower primordia initiated was also less in the experimental plants than in the control plants. Thus, the photoperiodic stimulus can be transferred across the incised stem, though with some difficulty.

In another experiment, quite similar results were obtained (Table 2, Exp. 2). The plants were exposed to a 16 hour dark period, and flowering responses in plants with incised stem were far less than in the control plants.

Discussion and Summary

From the present experiments, it may be concluded that the transmission of photoperiodic stimulus occurs only through living cells, not through vessels, and that it is somewhat inhibited by incisions made on the opposite flanks of the stem, through which the stimulus is transferred.

Because of the technical difficulties of the incision experiments we are not sure whether all the conductive strands of the stem had been severed or some of them remained intact. Also the possibility of diffusion of the stimulus through an incised surface can not be excluded, as no device against diffusion was applied. Therefore from this experiment neither the mode of transmission nor the tissue concerned can be with certainty established.

In a plant with two buds the developing bud on the higher node received more stimulus and produced more flower primordia than that on the lower node. Recently, Salisbury reported that an actively growing bud of *Xanthium* has higher sensitivity to photoperiodic induction than a dormant one, i.e. if actively growing buds are removed during or after induction, the dormant buds, when they become active, remain vegetative (5). This is also the case in *Pharbitis Nil*. In the present investigation, in plants with two buds the bud on the higher node was activated immediately upon removal of the main axis but that on the lower node was dormant or nearly so, and was forced to develop about 20 days after the photoperiodic treatment.

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SHORT COMMUNICATION

Hideo TORIYAMA^{**}: Preliminary Note on the Migration of a Colloidal Substance in the Motor Tissue of *Mimosa pudica*^{*}

鳥山英雄^{**}: オジギソウの運動組織におけるコロイド状物質の移動

Received October 26, 1956

Leaflets, petioles or whole branches of *Mimosa pudica* are known to show an appearance of wilt by stimulation. This change in the turgor of the responsible tissue cells is supposed to have a close relationship to the behavior of potassium ions in the tissue, which has been analysed in detail previously.²⁾ The present author was able to observe the translocation of some kind of colloidal substance in the

^{*}This report was presented at the annual meeting of the Botanical Society of Japan, held in July, 1956 at Sapporo.

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motor tissue of primary pulvinus at the moment of bending movement as described below. In this report, tissue cells of the upper and the under side of the pulvinus are chiefly dealt with.

Mimosa was cultivated in the same manner as had been described in the previous paper.^{1,2)} For the observation of the motor cells before receiving a stimulus, the plants were exposed to ether vapour for 15 to 20 minutes, thus rendering the pulvinus of these plants incapable of responding to any stimulus. The material was then fixed with Müller's fluid, Regaud's fluid or Zenker's fluid etc. The fixed material was washed by running water 8 to 10 hours. These tissues were cut in sections of 20 to 40 micra thick by a cylinder microtome or by a hand razor. In order to stain the protoplasm the author tried to use 0,1 and 0,05 per cent water blue and other dyes.

Before receiving a stimulus, both the colloidal substance and the tannin vacuole were found to be as inclusions of the central vacuole (Figs. 1, 3). But after receiving a stimulus, the colloidal substance ceased to appear in the vacuole, while the tannin vacuoles remained still observable in the cell. The colloidal substance was observed to have flowed out into the intercellular spaces (Fig. 2). This phenomenon was especially noticeable in the zone where numerous intercellular spaces are found. Figure 5 is the schematic figure in which the distribution of the colloidal substance in the intercellular spaces is illustrated. It means that the colloidal substance issues from the motor cells into the intercellular spaces at the time of bending movement. The migration of potassium ions in these spaces was studied particularly in the previous work. And there can be no doubt to assume that the K^+ ion is an ingredient of the colloidal fluid. The recovery from the bending posture may be brought about by the recovery of turgor which can be attained probably by the restoring permeation of the colloidal substance and potassium ions through the motor cell membranes. From this consideration it can be suggested that the permeability of the cytoplasm for the colloidal substance together with potassium ions increases in the duration of time between the bending movement and recovery.

The colloidal substance is fixed with fixatives such as Müller's fluid, Regaud's fluid, and Zenker's fluid which contain potassium bichromate solution. Furthermore, Champy's fluid and 10 per cent neutral formalin are also suitable for fixing the colloidal substance. In any case, this substance as well as protoplasm is stainable with 0,1 or 0,05 per cent water blue solution. However, the best result was obtained by using Müller's fluid and water blue staining. Further details of the chemical nature of this colloidal substance will be reported in another paper in the near future.

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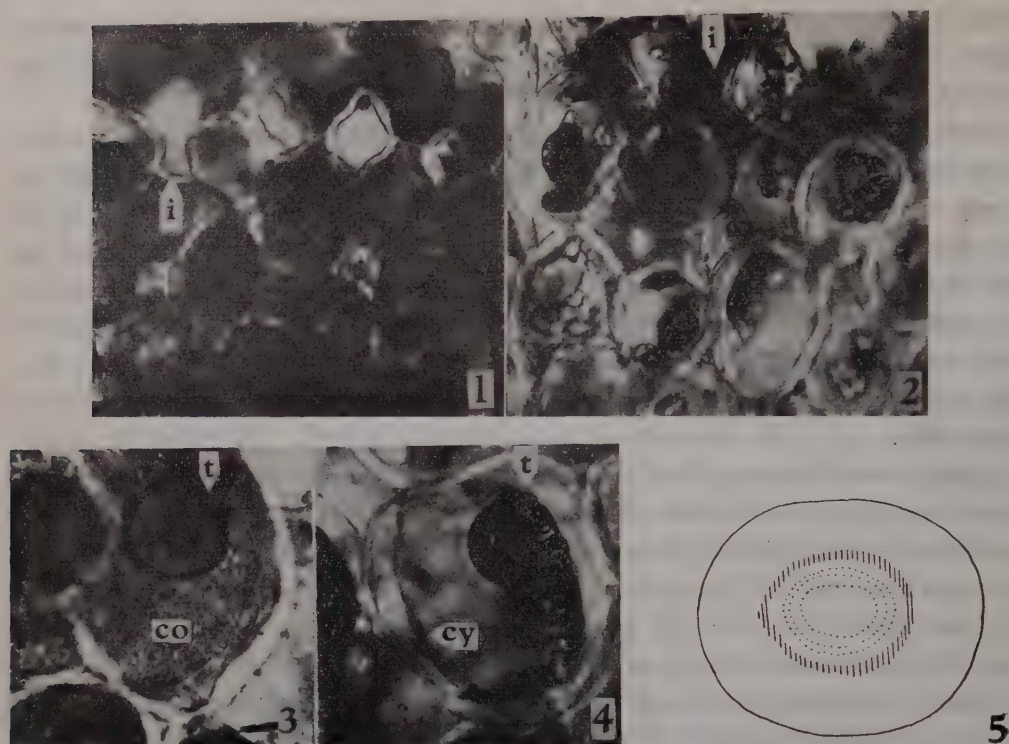


Fig. 1. Motor tissue before bending movement. Fig. 2. Motor tissue after bending movement. Both materials fixed with Müller's fluid and stained with 0.1% water blue. $\times 480$. i, intercellular space. Fig. 3. Motor cells before bending movement. Fig. 4. Motor cells after bending movement. Both materials fixed with Müller's fluid and stained with 0.05% water blue. $\times 800$. t, tannin vacuole; co, colloidal substance; cy, cytoplasm. Fig. 5. Schematic figure of the cross section of primary pulvinus. Lined area shows colloidal substance which is issued into intercellular spaces.

本会名誉会員 牧野富太郎氏は昭和32年1月18日
死去されました。ここに報告し謹んで哀悼の意を表し
ます。

日本植物学会

The Oxidation of Glucose and Gluconic Acid in *Acetobacter suboxydans*

by Yasuko YOSHIE* and Kyōko KAMEYAMA**

吉家やす子*・亀山鏡子**: *Acetobacter suboxydans* におけるブドウ糖及びグルコン酸の酸化

Received August 16, 1956

Several workers have recently indicated that in some molds and bacteria¹⁾, despite of the presence of aerobic metabolism of glucose, the anaerobic pathway of its breakdown which is shown by the Embden-Meyerhof-Parnas formula cannot be found. A more precise work on the carbohydrate oxidation by *Pseudomonas fluorescens* was reported by Wood and Schwerdt (6, 7), where a characteristic feature of bacterial glucose oxidizing system was suggested.

*Acetobacter suboxydans*²⁾, one of the typical saccharophilic bacteria, strongly oxidizes glucose to gluconic acid under aerobic condition and cyanide inhibits the oxidation. The bacteria show strong cytochrome bands, positions of which are distinctly different from those of ordinary aerobic organisms (so-called abc-type), but are rather close to those of a strain of halotolerant bacteria (so-called a₁b₄-type) (8).

We took an interest not only on the nature of the oxidase, but also on the roles of this characteristic cytochrome in respiratory system. As the preliminary step of precise studies we intended to obtain informations about general characteristics of the oxidation system of this *Acetobacter* strain and in the present report some significant facts revealed are described.

Methods

Method of Culture—The bacteria used were always cultured on agar plates in Roux' flasks of a half liter volume. The media were prepared by the following procedure. Ordinary Kōji digest (9) was boiled and the filtrate was mixed with extract from dry yeast of 1 per cent by weight of the final solution and added with 1.5–2 per cent agar and 3 per cent calcium carbonate.

Bacterial Suspension—After the cultivation for 5 days at 30°, the harvested bacteria were washed with 0.85 per cent solution of common salt and then with

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1) For example, in yeast (1), *Aspergillus niger* (2), *Escherichia coli* (3), *Pseudomonas aeruginosa* (4) and *Pseudomonas saccharophila* (5).

2) The strain used in the present work was kindly supplied from the Laboratory of Prof. T. Asai, Department of Agricultural Chemistry, Faculty of Agriculture; University of Tokyo.

distilled water on the centrifuge. The obtained bacterial paste was suspended in distilled water and stored in refrigerator.

The yield of bacteria was usually about 100 mg in dry weight from each cultural flask.

Preparation of Cell-Free Extracts—Fresh paste of bacteria diluted with distilled water or 1/30 mole phosphate buffer (pH 6.5) was ground with fine quartz-sand in a chilled bacterial mill of Utter-Werkman type. A reddish brown, somewhat viscid and slightly opalescent solution was obtained on the centrifuge at 2000 *g* for 20 minutes.

Determination of Gas Exchanges—Gas exchanges were measured manometrically using Warburg apparatus at 25° or 30°.

Reduction of Dyes under Anaerobic Condition—To determine the activity of dehydrogenases Thunberg's technique was employed at 30°. Methylene blue and 2,6-dichlorophenol indophenol were used as the hydrogen acceptor in most experiments.

Observation of Cytochrome Spectra—An ocular spectroscope (Abbe's spectral ocular, Zeiss) was used for the observation.

Results

I. Oxidation System of Glucose

Specificity to Related Substrates—Disaccharides, methylglucosides³⁾, pentoses and hexoses except glucose, so far tested, cannot be attacked or are oxidized only in small rates⁴⁾ by the bacteria (Table 1), demonstrating a fairly strict structural specificity. Similar results have been reported also on some mold enzymes (10, 11, 12).

Q_{O_2} of the oxidation of glucose by intact cells was estimated as about 800 (μ l/mg dry weight, hr) at pH 5.8.

Table 1. Relative activities on the oxidation of various saccharides.
5 $\times 10^{-2}$ M substrates, 0.1 M phosphate buffer (pH 6.5), at 30°. Total: 2 ml.

Substrate	Relative activity	
	Intact bacteria	Cell-free preparation
d-Glucose	100	100
d-Galactose	15	43
d-Xylose	15	30
d-Mannose	15	30
Methyl- β -glucoside	15	0
Methyl- α -glucoside	5	0
1(+)-Rhamnose	0	—
d(-)-Fructose	—	0
Fructose-1,6-diphosphate	—	0
Sucrose	0	—

3) Both optical isomers of methylglucoside could be in use by the courtesy of Prof. T. Miwa in the Biological Institute, Faculty of Science, Tokyo University of Education.

4) We cannot exclude some possibilities of the presence of small amount of glucose in these sugar preparations.

Michaelis Constant—The Michaelis constant of the glucose enzyme was found to be about 0.006 M/l in the intact bacteria and 0.003 in the enzyme solution (Fig. 1). It is of the same order as that of the mold enzyme (13).

Effect of Hydrogen Ions—As shown in Fig. 2, the optimum pH was shown to lie between 5 and 7 in the intact cells and this optimum range is narrowed to the neutral side (pH 5.5–7.0) in the enzyme solution, because of the precipitation of the enzyme protein that probably set in below pH 5.

Inhibition by Heavy Metal Reagents—In every case of so-called hematin reagents inhibition of the glucose oxidation were of a remarkable extent (Table 2), while three known copper reagents, 8-hydroxyquinoline, diethyldithiocarbamate and salicylaloxim exhibited only slight inhibiting action in a concentration of 10^{-3} M. It may be a noticeable fact that cyanide inhibited intact bacteria stronger than the enzyme in solution. Carbon monoxide inhibition was of the same order as those with other micro-organisms, whereas the recovery by light was provoked only in a small extent, unlike the cases of most other organisms except some coli-type ones.

Effect of Partial Pressure of Oxygen—Results are shown in Fig. 3. The dependency on the oxygen pressure is smaller in the enzyme solution than in intact cells.

Significance of Cytochrome Spectra—Three components of cytochrome: the suspension of bacteria as well as the reddish brown solution shows a well-marked reduction band at $554\text{ m}\mu$ (α -band) and correspondingly another weaker one at 520

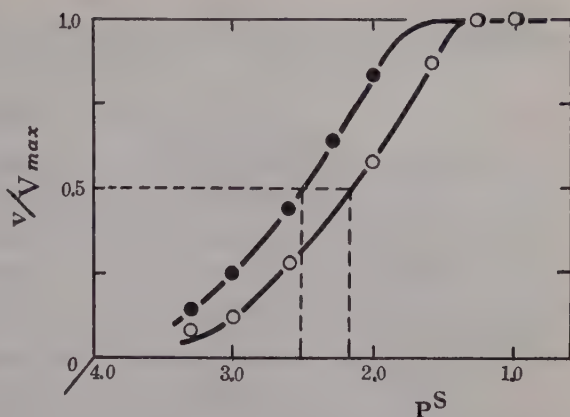


Fig. 1. Michaelis constant of the glucose oxidation. —●— cell free extract, —○— intact bacteria. 0.1 M phosphate buffer (pH 6.5), at 30.4° .



Fig. 2. pH-activity curves for the glucose and gluconate oxidation.

—○— dried bacteria, —▲— fresh bacteria, —□— cell-free extract, for glucose oxidation; —●— dried bacteria, for gluconate oxidation. 0.05 M substrates, 0.1 M phosphate buffer, in 4.0 ml, at 24° .

Table 2. Inhibition of the glucose oxidation by cyanide, azide, and carbon monoxide.
0.05 M glucose, 0.1 M phosphate buffer (pH 7.0). Total: 2 ml.

Inhibitor	Concentration of inhibitor (mole/l)	Inhibition (per cent)		Reaction temperature (degree)
		Intact bacteria	Cell-free preparation	
KCN	1×10^{-4}	98	70	30
	1×10^{-5}	80	30	
	1×10^{-6}	45	8	
NaN ₃	1×10^{-2}	80	—	25
	1×10^{-3}	15	—	
CO	95 % CO in the dark	76	40	30
	5 % O ₂ in the light	—	30	

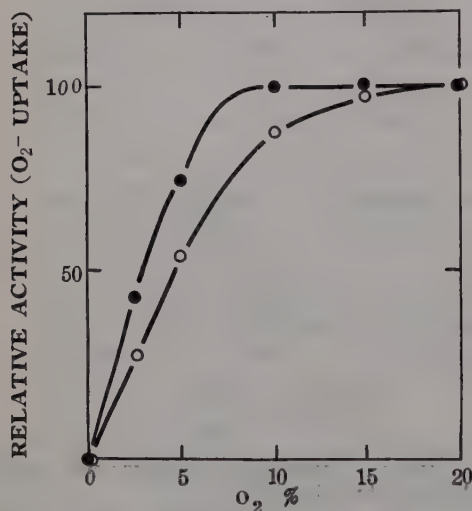


Fig.3. Effect of O₂-pressure on the glucose oxidation. —●— cell-free extract, —○— intact bacteria. 0.05 M glucose, 0.1 M phosphate buffer (pH 7.0), in 2.0 ml, at 25°.

—530 m μ (β -band). Moreover, it is likely to exist a faint band at about 560 m μ , which can be ascribed to component b. The two prominent bands can be regarded provisionally as that of component b₄. The bacterial cells show at least one more absorption band which was detected in the region of about 588 m μ . This component can be considered to be a₁ or a related compound. The spectra can be considered to have some resemblance to that of *Pseudomonas fluorescens* reported by Wood and Schwerdt (6), except for differences on the relative intensity of the bands and the position of b₄-like α -band (554 m μ).

No trace of absorption band could be observed at 550 m μ (of the component c) in agreement with the fact that *p*-phenylenediamine, a specific substrate for cytochrome c oxidase, was by no means oxidized.

Effect of pyridine and carbon monoxide: The position of the main band, 554 m μ , did not change appreciably by an addition of pyridine. That is also known as a character of b₄ of the halotolerant bacterium (8). When the suspension is brought

into contact with carbon monoxide in a Thunberg tube, the band at $588\text{ m}\mu$ is transferred to $593\text{ m}\mu$ and simultaneously it becomes remarkably sharper than before.

II. Some Experiments on the Glucose Metabolism

Accumulation of Gluconate as a Product of Glucose Oxidation—Since Boutroux's experiments (1896), *Acetobacter* has been known as a microorganism producing gluconic acid. Even in short time experiments of the glucose oxidation with our strain, the reaction of media declined distinctly to acid side. Moreover, it was likewise established that gluconic acid accumulated in Henneberg's medium in shaking culture for 2 weeks and could be isolated as calcium salt with a high yield more than 70 per cent, according to the procedure cited in the Bernhauer's book (13).

Decline and Recovery of Total Amount of Oxygen Uptake—The extent of the glucose oxidation diminished in the course of storing the bacterial suspension. It was found that the fresh washed bacteria absorbed oxygen more than one mole per mole of glucose added. The same large oxidation capacity was exhibited also by the addition of a small amount of succinate to the suspension of 3–4 days old whose total oxygen uptake dropped to a lower level by the storing, as shown in Fig. 4. On the other hand this propping effect of succinate disappeared when the bacterial suspension was stored further, and the O_2 -uptake stopped at a level between one mole and 0.5 mole per mole of glucose. With the enzyme solution the O_2 -uptake came to cease after consuming 0.5 mole of oxygen per mole of glucose. This level of O_2 -uptake remains, then unchanged for a week or more in both suspensions of washed bacteria and enzyme solution.

Concerning the gluconate oxidation, the total O_2 -uptake was less than one mole per mole of gluconate, usually corresponding to 0.5 mole less than that of glucose oxidation, when both oxidations were measured on the same preparations. The relative activity was only 10 per cent of the glucose oxidation. Any measurable amount of oxygen can scarcely be absorbed with 2-ketogluconate as substrate.

RQ value of 0.3 was obtained in the initial stage of the glucose oxidation by a fresh suspension which consumed oxygen more than one mole. On the other hand

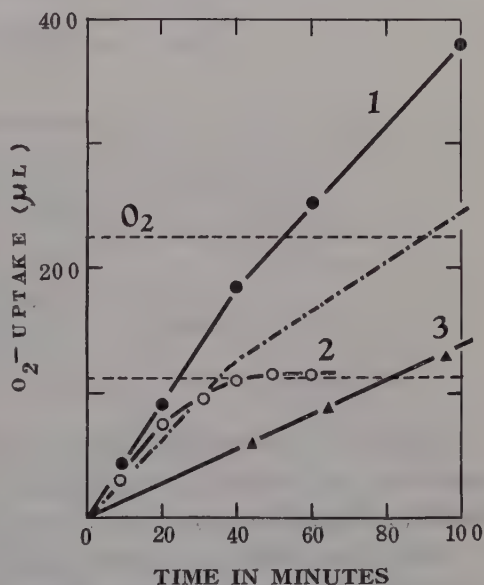


Fig. 4. Propping effect of succinate on the glucose oxidation.

1: glucose + succinate, 2: glucose, 3: succinate, - - - - - 1–3. M/300 glucose; M/30 succinate, M/15 KH_2PO_4 -borax buffer (pH 8.4), intact bacteria stored for 4 days, in 3.0 ml, at 25° .

in the gluconate oxidation by the same suspension RQ was enhanced gradually from 0.2 (at the beginning) to about 0.5 as the reaction proceeded.

Effect of Iodoacetate, Biarsenate, Sodium Fluoride and 2,4-Dinitrophenol—In Table 3 are collected the results of the experiments. Except dinitrophenol which revealed a slight inhibitory effect in both initial oxidation velocity and total oxygen uptake, other reagents known as inhibitors of the processes related to phosphorylation or some coenzyme linked oxidation-reduction did not affect the O_2 -uptake.

Table 3. Inhibition in the initial stage of the glucose and gluconate oxidation.
0.005 M substrates, 0.1 M phosphate buffer, at 30° (1, 2),
 25° (3, 4, 5). Total: 3 ml.

No. of experiment	Substrate	Inhibitor (mole/l)	Inhibition (per cent)	pH
1	Glucose	2, 4-Dinitrophenol ($1/6 \times 10^{-2}$) ($1/12 \times 10^{-2}$)	40 20	5.9
2	"	Iodoacetate (1×10^{-2})	0	6.7
3	"	Potassium biarsenate (1×10^{-2})	0	6.7
4	"	Sodium fluoride (5×10^{-2})	0	5.4
5	Gluconate	2, 4-Dinitrophenol (5×10^{-3})	50	5.4

Reduction of Oxidation-Reduction Dyes—The extract as well as the bacterial suspension can reduce some oxidation-reduction dyes with glucose as hydrogen donator, and cyanide exerted no inhibiting action on this reaction.

Redox dyes tested as hydrogen acceptors were the followings, where the numbers in the parentheses express their normal potential (in volt) at pH 7.0: methylene blue (0.011), toluidine blue (0.011) gallocyanin (0.021), and cresyl blue (0.032). All of these could be reduced by the glucose dehydrogenase, but thionine (0.06) and toluylene blue (0.113) were not suitable dyes, probably because of their changeable nature. Furthermore, it was found that 2,6-dichlorophenol indophenol is a very convenient dye for the test, reduction of which proceeds with some thousand times as rapid as that of methylene blue. 12 hours' long dialysis of the bacterial extract against distilled water caused no diminishing of the enzyme activity, both in reduction of dyes and in O_2 -uptake.

Table 4. Relative activities of dehydrogenases referred to lactic dehydrogenase.

Methylene blue in the concentration of one part in 5×10^4 parts water,
0.1 M phosphate buffer, at 30°. Total: 3 ml.

Substrate	Concentration of the substrate ($\times 10^{-2}$ mole)	pH	Reciprocal time ratio for the decoloration of		
			1/2	3/4	the whole
Lactate	5	6.7	10	10	10*
Glucose	"	"	7	3	3
Mannose	"	"	2	2	2.5
Formate	"	6.5	16	16	16
Succinate	2	6.7	6	9	2.5
n-Butanol	5	6.5	5	5	5
Gluconate	"	"	3.5	1.5	1.5

The bacterial suspension used in each Thunberg tube had an activity of 260 μ l of O_2 -uptake per 10 minutes.

*Time spent for the complete decolorization was 9 minutes.

Table 5. Relative activities on the oxidation of carboxylic acids and alcohols.

0.1 M phosphate buffer, intact bacteria, at 30°. Total: 2 ml.

Substrate	Concentration of the substrate ($\times 10^{-2}$ mole)	pH	Relative activity*
Propanol	5	6.7	100*
Ethanol	"	5.8	100
Lactate	"	6.7	100
Formate	"	5.8	90
Butanol	10	"	85
d-Mannitol	5	6.7	80
Pyruvate	2	7.2	30
Malate	5	5.6	15
Succinate	"	8.4**	10
Fumarate	"	7.2	10
Ethylene glycol	"	6.7	5
Acetate	"	5.6	5

* The activity for glucose is taken as 100. ** KH_2PO_4 -borax buffer.

In Table 4 are shown the lengths of time spent to reach a definite grade of decoloration with several substrates in values referred to that for lactate as 10.

Other Substrates Utilized in Respiration—Relative amounts of oxygen uptake with various substrates are summarized in Table 5. Glycerol, ascorbic acid, fatty acids (butyric and propionic acids), di- and tricarboxylic acids (oxalic and citric acids) and *p*-phenylenediamine were not utilized by the bacteria.

Lactate is highly available as substrate and pyruvate can be oxidized also with a fairly large rate, comparing with other most common metabolites known as members of the tricarboxylic acid cycle. They were almost completely oxidized to CO_2 and H_2O by the fresh bacteria within a short time under our experimental condition.

In order to confirm the ability of alcoholic fermentation CO_2 production was examined in Einhorn tubes under the sterilized condition at 30° , but noticeable gas evolution from glucose or gluconate medium had never been observed.

Discussion

By an experiment of differential centrifugation of the cell-free water extract from dried bacteria it was found that the glucose oxidase activity remained almost completely in the supernatant by the centrifugation at 2,700 *g*, but an appreciable amount of the activity entered into the reddish sediment by a stronger centrifugation, that is, at 5,000 and 17,000 *g* only 44 and 38 per cent of the total activity remained in the supernatant respectively. This suggests that the enzyme is associated with protoplasmic particles of various dimensions.

From the results obtained, i. e. the strictly aerobic nature of the bacteria, the sensitivity to inhibitors of iron containing enzymes, and the reduction of the cytochrome by the addition of glucose in vacuum etc., we may conclude that the mechanism of action of our glucose enzyme should be different from that of enzymes which are already known since long years in molds and in mammalian liver (10, 11, 12, 14). In other words, the bacterial enzyme seems to be linked to the terminal oxidase system or the cytochrome components in the organism.

As to the action and the role of characteristic cytochrome in the glucose oxidation, followings would be stated. The lack of cytochrome *c*-band and of indophenol reaction indicated the absence of ordinary cytochrome system of the heart muscle type, although some kind of oxygen transporting system was proved to exist, as indicated by the remarkable inhibition of respiration by carbon monoxide as well as by the shifting of the a_1 -like band⁵⁾ in its presence.

5) Recently L. N. Castor and B. Chance (15) reported that some microorganisms, i. e. *Acetobacter suboxydans* and *Micrococcus pyogenes* var. *albus*, contain a protohemin-like oxygen-transferring enzyme based on their observation of difference spectra. The type of this enzyme was, however, reported as wholly different from that of *Acetobacter pasteurianum* which has cytochromes a_1 and a_2 . Our strain of *A. suboxydans* seems to be different from that of Pennsylvania, because the cytochrome type of ours is very similar to that of *A. pasteurianum*.

It was detected that the present *Acetobacter* lacks the faculty to reduce nitrate, nitrite and hydroxylamine, or if it were, in only very slight degree⁶⁾. Little ambiguity exists to believe that the b_4 -like cytochrome has no direct relation to reductases of nitrate, nitrite, etc. what might be often presumably suspected in other kinds of bacteria (16, 17). Namely, the cytochrome component can act merely as a suitable mediator of the oxidation-reduction, having no direct relation to the nitrate or nitrite metabolism.

Observations described in the latter part of this paper indicate that the essential reaction of the glucose utilization is no other than the oxidation of glucose itself. Further oxidation via gluconate and 2-ketogluconate, however, is never predominant in the present bacteria, because the promptly produced gluconate is accumulated and oxidized only with one-tenth rate as that of glucose. We can disregard the possibility of glycolytic process confidently, but have not yet any positive evidence to exclude the possibility of the route through the so-called "hexose monophosphate shunt" or "phosphogluconate pathway".

One may come to the conclusion that in our strain of *Acetobacter* main energy supplies are perhaps also attained by phosphorylations, which should be linked to and coupled with some steps of further breakdown of gluconate. Following facts are worth to be mentioned in this point of view: 1. Complete oxidation of both lactate and pyruvate, suggesting that they may be produced possibly as intermediates in the course of the glucose oxidation⁷⁾. 2. Propping effect of succinate, as a mediator in the further breakdown of glucose, indicating the possibility of participation of TCA- or otherwise more probably DCA-cycle in the further breakdown of gluconic acid.

Summary

1. *Acetobacter suboxydans* was cultured on Kōji-juice agar containing yeast extract. A reddish brown cell-free extract was obtained by grinding bacteria with quartz-sand.

2. The specificity for respiratory substrates was studied. An enzyme system was found which oxidized glucose under aerobic condition very intensely ($Q_{O_2} = 800$). The Michaelis constant was 0.006 (M/l) in the intact bacteria (opt. pH 5—7) and 0.003 (M/l) in the cell-free solution (opt. pH 5.5—7).

3. Cyanide, NaN_3 and CO inhibited the activity of glucose oxidation strongly. The effect of partial pressure of oxygen upon the rate of glucose oxidation was examined.

6) The reduction of nitrate and nitrite was determined by the known color reaction of nitrite with Griess-Ilosva reagent with the aid of a filter photometer and that of hydroxylamine in the same manner after conversion into nitrite by means of iodine.

7) There are, however, some reports asserting that pyruvate is not an intermediate produced in the direct oxidation of glucose by some kinds of molds through 2-ketogluconate (18).

4. The reduced cytochrome spectrum consisted of three main absorption bands, namely at $588\text{ m}\mu$ (slightly), $554\text{ m}\mu$ (strong), and $520\text{--}530\text{ m}\mu$ (weak). These are attributed to two components. The first one was transferred to $593\text{ m}\mu$ by the action of CO. The second component corresponding to $554\text{ m}\mu$ was reduced by the addition of glucose under the anaerobic condition. Those were extracted from the bacterial cell accompanied with the glucose enzyme. Neither the cytochrome band of component c, nor indophenol oxidase system could be detected.

5. The production of gluconate from glucose was confirmed, but gluconate was oxidized only at one-tenth rate as that of glucose. In order to apprehend the pathway of the glucose breakdown, some experiments were undertaken.

6. In anaerobic experiments 2,6-dichlorophenol indophenol was found to be a suitable hydrogen acceptor for the glucose oxidation. This anaerobic reaction was not inhibited by cyanide. On the other hand the bacteria lacks fermentation ability.

This work was carried out under constant guidance of Mr. Akira Tsukamoto, lecturer of plant physiology, in 1952. Some results obtained since 1953 in Nagoya University were added by one of us (Yoshiie). We wish to express our thanks to Mr. Tsukamoto. Thanks are also due to Prof. Dr. Takeshi Mori for his some valuable suggestions and proper aid given during this study in Nagoya University.

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Preliminary Note on the Stimulative Effect of Certain Specific Bacteria upon Fruit Body Formation in *Psilocybe panaeoliformis* Murrill*

by Takashi URAYAMA **

浦山隆司**, 担子菌 *Psilocybe* の子実体形成に及ぼすバクテリアの刺激効果 (予報)*

Received September 8, 1956

In the course of the study on *Psilocybe panaeoliformis* Murrill, a small hymenomycete grown on a field manure pile, the author was confronted with the unexpected fact that fruit body formation seems to be stimulatively affected by a certain contaminating bacterium, provisionally called '*Bacillus Psilocybe 1*'.

This stimulation even occurs in the C(sucrose)-N(peptone) ranges of cultural media unsuitable for fruit body formation¹⁾, namely in higher concentrations of peptone as against sucrose.

The contamination first occurred during the dripping of autoclaved maize extract to the mycelial colony in the test tube, though the extract itself did not indicate any favorable effect. The bacterium was similar to *Bacillus circulans* Jordan or *B. cereus* Frankland and Frankland. An aspect of the stimulating effect is shown in Fig. 1.

The efficient range of temperature upon the stimulation of the bacterium almost coincides with the growth range of the fungus. It was 10°-35° C, the optimum being 25°-35° C. Any fall in temperature seems to be unnecessary for the fructification of the fungus.

Inoculation of the bacterium is effective at a distance about 2 cm or more from the fungus colony. The initiation is seen 5-7 days after inoculation, even without coming into contact with the bacterium. The induction becomes slower with the increase of peptone concentration in the medium.

It was probable from these and other experiments that the stimulative effect of the bacterium is not due to such changes of media as C-N ratio or pH, but it is related to something produced by the bacterium.

* Read at the 20th annual meeting of the Botanical Society of Japan on October, 1955, at Hiroshima.

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1) The media have following composition: KH_2PO_4 0.25g, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ 0.25g, $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ 0.25g, KCl 0.12 g, FeCl_3 trace in 1000 cc dist. water with 20 g agar and sucrose and peptone in various amounts. The chemicals used are "extra pure" or "for analysis" with the exception of peptone and agar. In the lower peptone concentrations (against sucrose) the fungus fructifies without the bacterium.



Fig.1. The stimulative effect of '*Bacillus Psilocybe 1*' (↓) upon the fruit body formation of *Psilocybe panaeoliformis* Murrill grown on 1 % sucrose—0.1 % peptone agar medium at 30° C.

Left: mycelial colony cultured for 11 days without bacterium (control).

Right: mycelial colony with fruit body primordia in various stages, 6 days after bacterial inoculation.

Some manure-fungi as *Coprinus macrorrhizus* Rea f. *microsporus* Hongo and *Psilocybe* sp. also responded to the bacterium in the same way.

The effective principle was dialysable from a water solution of bacterial culture through cellophane membrane. It is ether-insoluble, heat-resistant up to 100° C, but not stable to weak acid or weak alkaline solutions and is divided into not less than four parts by one dimensional paper chromatography. The precise nature of these substances awaits further investigation.

Nineteen known species of bacteria including *Bacillus cereus* var. *mycoides*, *B. megatherium*, *B. subtilis*, *Agrobacter tumefaciens*, *Erwinia milletiae*, *Escherichia coli*, *Sarcina lutea* and *Staphylococcus aureus*, as well as many of unknown bacteria picked out from the air, water and soils did not display this stimulative effect, except *Bacillus Psilocybe 2* and 3 which were also effective.

The writer wishes to record here his gratitude to Prof. Shun-ichiro Imamura and Dr. Minoru Hamada for their kind advice, and to Prof. Alexander H. Smith, Michigan Univ., U.S.A. for the identification of the fungus, and Prof. Motoki Yamana, Osaka Medical College for the bacterial survey.

タデ属に於ける花粉形成過程について

土 井 田 幸 郎*

Yukio DOIDA*: On the Pollen Grain Formation in Genus *Polygonum*.

1956 年 7 月 20 日 受 付

花粉形成、タペート細胞 (tapetal cell) の発達及び機能について、更に造胞細胞とタペート細胞との相互関係について色々の論議がなされてきている。タデ属に於ける研究も Linnaeus 氏⁽⁶⁾ や Meisner 氏^(7,8) に始まり、杉浦氏⁽¹¹⁾ はオシタデ (*Polygonum savatieri* Nakai) を用い花粉母細胞 (PMC) の分裂を見ている。篠遠氏等⁽⁸⁾ はソバに fast neutron を作用させ、花粉粒の異常を見ている。又 Hedberg 氏⁽³⁾ は花粉の形態を観察し、タデ属を7つのグループに分けている。

筆者は本邦産タデ属植物を観察した結果、本属は同じタデ科のギシギシ (*Rumex*) 属と異なり一花粉囊中、極めて少数の花粉粒しかもたない事を見出したので、この点について報告し併せて花粉粒形成までの形態的観察結果を述べる。

なお本論を草するにあたり、本研究に有益な御教示をして戴いた名古屋大学 島村環教授、及び終始懇篤なる御指導、助言を賜った名古屋大学 加藤幸雄氏に深甚の謝意を表します。

材 料 及 び 方 法

本研究に用いた材料は第一表に示された種で、それ等は愛知、岐阜、長野の諸県で採集された。

花粉形成過程は切片標本で観察された。即ち、色々な発達段階の蕾をもつた花序を切り Navashin 液、Carnoy 液、Bouin 液及び昇汞—alcohol 混液 (昇汞飽和水溶液 1 容: 95 % ethyl alcohol 1 容) 等で固定、脱水、paraffin 包埋後 10~15 μ の切片を作った。染色は主として haematoxylin に依ったほか、Feulgen 反応、Lillie 氏の高糖類染色法、pyronine-methyl green 混液等を用い

た。一方、一花粉囊中の花粉数を算えるために、開花直前の蕾より葯を摘出し、更に葯を二片 (各片は二花粉囊をもつ) に分離し aceto-carmin 液で染色した。ハルタデ (*P. persicaria*) 等二、三種に於いては、腊葉標本より花蕾をとり、Erdtman (2) の acetolysis method を適用し観察した。これら腊葉標本の蕾は、極めて乾燥しており破壊され易く、花粉数に変化を起す恐れがあるので、この点注意した。

観 察

(I) 花粉形成過程について。

タデ属の葯はすべて4花粉囊をもち、各花粉囊は各4細胞層により取巻かれている。外側より表皮 (epidermis)、内被層 (endothecium layer)、中間細胞層 (transitional layer) 及びタペート細胞層 (tapetal layer, tapetum) である。

雄蕊は、最初花芽の生長点部分に小突起として現われるが、此の突起を構成する細胞間には如何なる形態的变化も配置の規則性もない (Fig. 1)。この突起の生長に続いて、一個の大型の細胞が皮下細胞層に出現し、これが胞原細胞になる。細胞の大きさ及び核の染色力の違いにより、はっきり他の細胞と区別しうる (Fig. 2)。胞原細胞の分化後も周辺の細胞は分裂を繰返し、胞原細胞を取巻く3細胞層、即ち、表皮、内被層、中間細胞層となる (Fig. 3)。タペート細胞は中間細胞の分裂により胞原細胞側に切り出される (Fig. 4)。タペート細胞層の完成と共に周辺細胞の分裂は終り、花粉囊は4細胞層によって取巻かれるにいたる (Fig. 5)。続いて胞原細胞は種によって定まった

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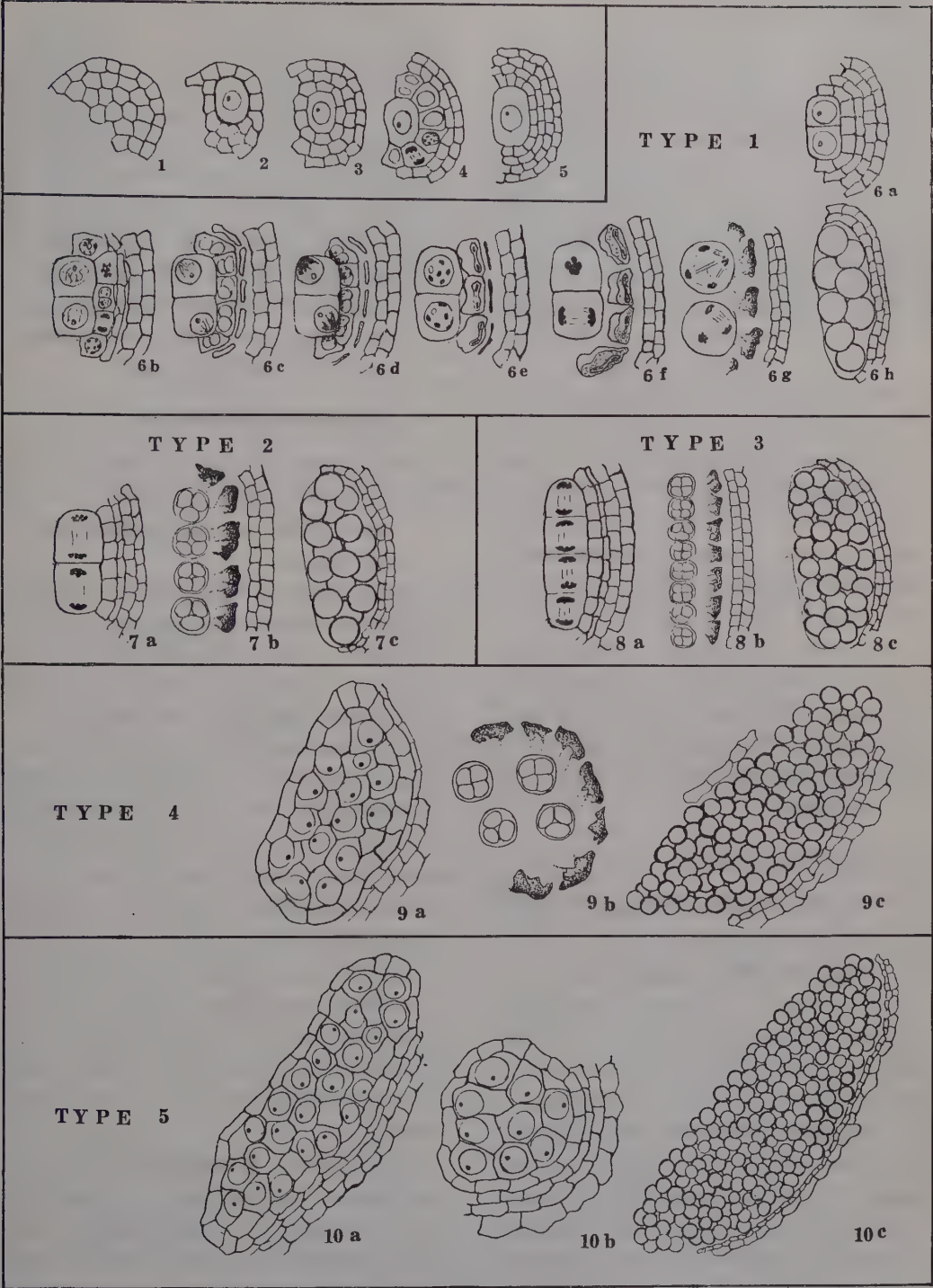
Table 1. The species-names used in this study, and the number of pollen mother cells and pollen grains in a pollen sac of the genus *Polygonum*.

Japanese Name	Latin Name	Number of PMCs	Number of Mature Pollen Grains	Type of Pollen-grains-Formation
オ オ イ ヌ タ デ	<i>Polygonum nodosum</i> Pers.	2	8	Type 1
イ ヌ タ デ	" <i>blumei</i> Meisn.			
ハ ナ タ デ	" <i>yokusaianum</i> Makino			
サ ナ エ タ デ	" <i>lapathifolium</i> Linn.			
ネ バ リ タ デ	" <i>viscoferum</i> Makino			
マ タ デ (ム ラ サ キ タ デ)	" <i>hydropiper</i> L. var. <i>vulgare</i> Meisn.			
ボ ン ト ク タ デ	" <i>flaccidum</i> Meisn.			
ミ ズ ヒ キ	" <i>filiforme</i> Thunb.			
マ マ コ ノ シ リ ヌ グ イ	" <i>senticosum</i> Franch. et Savat.			
イ シ ミ カ ハ	" <i>perfoliatum</i> Linn.			
ナ ガ バ ノ ウ ナ ギ ツ カ ミ	" <i>hastato-sagittatum</i> Makino	4	16	Type 2
ア キ ノ ウ ナ ギ ツ カ ミ	" <i>sagittatum</i> Linn.			
	var. <i>sieboldi</i> Meisn.			
ヤ ノ ネ グ サ	" <i>nipponense</i> Makino			
ミ ゾ ソ バ	<i>Polygonum thunbergii</i> Sieb. et Zucc.			
オ オ ミ ゾ ソ バ	" <i>thunbergii</i> Sieb. et Zucc.			
	var. <i>stoloniferum</i> Makino			
シ ロ バ ナ サ ク ラ タ デ	<i>Polygonum japonicum</i> Meisn.	8	32	Type 3
オ オ ゲ タ デ	" <i>orientale</i> Linn.			
オ ミ チ ヤ ナ ギ	" <i>aviculare</i> Linn.			
ム カ ゴ ト ラ ノ オ	" <i>viviparum</i> Linn.			
ソ バ カ ズ ラ	" <i>convolvulus</i> Linn.			
ソ	<i>Fagopyrum esculentum</i> Moench. (= <i>Polygonum fagopyrum</i> L.)			
ダ ッ タ ン ソ バ	" <i>tataricum</i> Gaertn.			
シ ャ ク チ リ ソ バ	" <i>cymosum</i> Meisn.			
ツ ル ド ク ダ ミ	<i>Polygonum multiflorum</i> Thunb.	32	128	Type 4
ウ ラ ジ ロ タ デ	" <i>weyrichii</i> Fr. Schm.			
イ タ ド リ	<i>Polygonum cuspidatum</i> Sieb. et Zucc.	64	256	Type 5
メ イ ゲ ツ ソ ウ	" <i>cuspidatum</i> Sieb. et Zucc.			
オ オ イ タ ド リ	var. <i>compactum</i> Bailey <i>sachalinense</i> Fr. Schm.			

Explanation of Figs. 1-10.

The formation of pollen-grains in genus *Polygonum*.
(Longitudinal section; Figs. 9b, 10b cross section.)

1. Anther primordium. 2. Growth of the archesporial cell in hypodermal layer. 3. Archesporial cell is surrounded by the following layers; epidermis, endothecium and transitional layer. 4. Differentiation of the tapetum from transitional layer. 5. Formation of the tapetal cell layer. 6a. 2 PMCs produced by the division of an archesporial cell. 6b. First mitotic division in tapetal cell. 6c-d. The nuclei of PMCs are in the periphery of the cell and nuclei of tapetal cells are located in the innerside. 6e. The PMCs and tapetal cells separated each other, and the tapetal cells vacuolated. 6g. 2nd meiotic division. 6h. 8 pollen grains in a pollen-sac. 7a. Mitosis of archesporial cell; 4 PMCs are produced. They arrange in row, parallel to the longitudinal axis of a pollen sac. 7b. 4 tetrads in a pollen sac. 7c. 16 pollen grains in a pollen sac. 8a. Last mitosis of archesporial cell. 8 PMCs arrange in row, parallel to the longitudinal axis in a pollen sac. 8b. 8 tetrads. 8c. 32 pollen grains. 9a. Longitudinal section of anther. PMCs arrange irregularly. 9b. Cross section of anther. 9c. 128 pollens in a pollen sac. 10a. Longitudinal section of anther. 10b. Cross section of anther. 10c. 256 pollen grains in a pollen sac.



Figs. 1-10 c

回数だけ分裂し PMC を形成する (後述)。

胞原細胞から花粉粒形成までの過程については *P. nodosum* を例として以下にのべる。

タペート細胞層の完成後、胞原細胞は花粉嚢の長軸方向に一回だけ分裂し、そのまゝ2個のPMCとなる (Fig. 6a)。この間タペート細胞は休止期に入っている。PMCの休止期から成熟分裂の第1分裂前期にいたる時期にタペート細胞の核は最初の分裂をする。この分裂は有糸分裂で、従って紡錘体も形成される。しかし細胞質分裂は起らないので、すべての細胞は2核性細胞となる (Figs. 6b-c)。なおタペート細胞の分裂の時期は各細胞でまちまちで、何等同時性は見られない。

PMCの成熟第1分裂前期にPMCの核は細胞の周辺部に移動し、同時に細胞内壁に位置するタペート細胞の核と細胞膜を界して接する。その時に両核の核質 (Feulgen positive materials) も接触面に辺在するようになる (Fig. 6d)。此の時期を前後として、両核の間の pyronine-methyl green 混液に対する染色性に著しい変化が見られるが、なお検討の余地があるので、こゝでは報告しない。太糸期になると偏在していた核は中心に戻ってくる (Fig. 6e)。一方タペート細胞は急激に空胞化し、同時に PMC から分離し、後中間細胞と共に退化消滅する (Figs. 6e-h)。以後のPMCの分裂過程は杉浦氏⁽¹¹⁾の報告とほぼ同様なので、この点には触れない。

(II) 花粉粒形成の形式について。

タペート細胞完成後に起る胞原細胞の分裂回数は種に依って定まっている。

(i) 1花粉嚢中に PMC が2箇生じる場合。

第1表の Type 1 に示される種がこれに属す。胞原細胞は葯の長軸方向に一回分裂し、その結果2箇のPMCが生じ、各々の減数分裂の結果8個の花粉粒が形成される (Figs. 6a-h Type 1)。

(ii) 1花粉嚢中に4箇のPMCを生じる場合。

P. thunbergii 等に於ては葯の長軸の方向に胞原細胞は2回分裂し、その結果4箇のPMCが生じ、葯の長軸方向に一列に並び (Figs. 7a-b)。各々の減数分裂により、合計16箇の花粉粒を形成する (Figs. 7a-c Type 2)。

(iii) 1花粉嚢中に8箇のPMCを生じる場合。

P. aviculare 等、第1表の Type 3 に示した種

では、胞原細胞は更に1回葯の長軸の方向に分裂し、8箇のPMCはFigs. 8a-bに示せる如く、葯の長軸方向に一列に並び、合計32箇の花粉粒を形成する (Figs. 8a-c Type 3)。

(iv) 1花粉嚢中に32箇のPMCを生ずる場合。

P. multiflorum のPMCは前述の3型と異なり、花粉嚢中で長軸方向への直線的配列を示さない。第一表 Type 4 に示した此種のものは128箇の花粉粒を生ず (Figs. 9a-c Type 4)。

(v) 1花粉嚢中に64箇のPMCを生ずる場合。

P. cuspidatum は更に多くの花粉粒を形成する。即ちPMCで64箇、従って256箇の花粉粒をもっている (Figs. 10a-c Type 5)。

(III) 花粉粒形成過程に於ける異常

花粉粒の形成過程は前述の如く種によって特有であるが、Table 2 及び Figs. 11-14 に示した如く、小数の花粉嚢においては、花粉数の異常を示す場合が見られた。

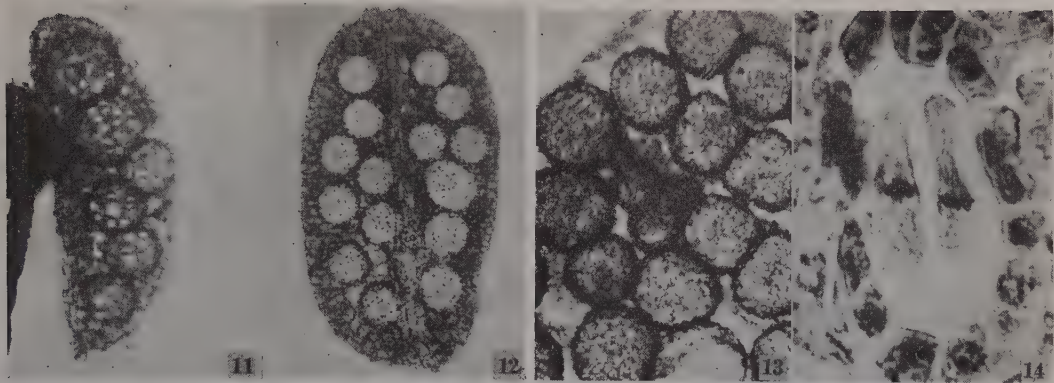
(a) *P. flaccidum* において花粉数6なるものが見られた。Fig. 11 でみられる如く、その内の2箇は著しく大きい。これは減数分裂のある時期にPMCの1箇で細胞質分裂を省略し、そのため1箇のdyadが形成されたためと考えられる。

(b) *P. nodosum* で1花粉嚢中7箇の花粉をもつものをみた。Fig. 12 からこれは2箇のPMCの分裂で1箇のtetradと1箇のtriadが形成されたためと思われる。下部の3箇は上部の4箇に比して大きく、その中、1箇は特に大きい。

(c) *P. thunbergii* で Fig. 13 に見るような小花粉を観察した。

(d) 胞原細胞は葯の長軸方向に分裂するが、*P. senticosum* において Fig. 14 に見る如く、葯の長軸と直角の方向に分裂したのを見た。ジュータン細胞が2核性であることより、2細胞はいずれもPMCで減数第一分裂の中期であることが納得される。

(e) Table 2 の *P. nodosum* 等の例でみられる花粉粒数4及び12のものは、胞原細胞の分裂で2箇のPMCを生ずべき所、分裂せず、そのまゝ1箇PMCになったり、あるいは2箇のPMCになるべき細胞のうち1箇が更に分裂して3箇のPMCになった結果4箇或いは12箇の花粉粒が生じたと考えられる。



Explanation of Figs. 11-14: Abnormality of pollen grain formation.
11. 6 pollen grains. 2 are larger than other ones (normal size). A failure of cytokinesis in meiosis of PMC may result in such abnormality (*P. nodosum*).
12. 7 pollen grains in a pollen-sac. Three out of them are larger in size than others. Pollen-sac of the right in this figure is normal (*P. flaccidum*). 13. Normal pollen grains and micro-pollen grains (*P. thunbergii*). 14. Abnormality of division-axis in an archesporial cell. 2 PMCs arrange in the right angle to long axis of anther (*P. senticosum*).

Table 2. Variation of number of pollen-grains in a pollen sac.

Polygonum nodosum

	Number of Pollen									Total	Mode
	4	5	6	7	8	9	10	11	12		
Number of Cases	2	0	2	8	46	0	1	0	6	65	8

Polygonum flaccidum

	Number of Pollen									Total	Mode
	4	5	6	7	8	9	10	11	12		
Number of Cases	33	0	2	0	90	0	0	0	21	146	8

Polygonum thunbergii

	Number of Pollen									Total	Mode
	12	13	14	15	16	17	18	20	24		
Number of Cases	9	1	0	1	52	0	1	19	2	85	16

Polygonum aviculare

	Number of Pollen											Total	Mode
	28	29	30	31	32	33	34	35	36	40	44		
Number of Cases	16	2	2	4	38	4	1	2	6	1	1	77	32

考 察

タデ属植物は1花粉囊にふくむ花粉粒数が極めて少ない。かゝる例は非常に珍しい。花粉粒数の少ないことについては、山崎氏⁽¹²⁾がネムノキ

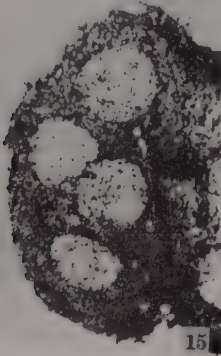


Fig. 15.

Photograph of the pollen-sac of *P. persicaria*.
4 pollen grains in a pollen-sac.

(*Albizzia glabrior* Ohwi var. *speciosa* Koidzumi) の減数分裂及び花粉粒分裂についての報告でふれられている。此種においては花粉粒は所謂花粉塊をなして存在し、各々の花粉塊は 16 箇の花粉粒よりなるという。

本邦産タデ属を観察した結果、1花粉囊中 8, 16, 32, 128 及び 256 箇の花粉粒をもつ 5 型を観察した。各々 Table 2 にみる如く数に多少の変異はあるが、大多数において正常の数をもっている。なお Fig. 15 に示した如く、花粉数 4 なる種もハルタデ (*P. persicaria*) で観察している。取材個体数が少数のため、まだ断定出来ないが、此種においては胞原細胞がそのまま PMC としての機能を果たすものと考えられる。

タデ属のタペート細胞は中間細胞層より形成されるが、この点に関しては飯島氏⁽⁴⁾がギシギシ属のそれが胞原細胞に由来すると報告されたのと異なる。

加藤氏⁽⁵⁾は *Allium odorum* の花粉形成の際の小花粉粒の形成を観察し、このものは減数分裂期における染色体の異常行動 (染色体切断、中期における核板からの染色体の逸脱等) によると報告されているが、*P. thunbergii* で見られた小花粉もかゝる染色体の異常行動によるものと思われる。

花粉数と花序や外部の形態との間の関係について論ずるのは早計とは思われるが、これらの間に何等かの関係がある事は確かなようである。大井氏⁽¹⁰⁾の分類と筆者の場合とを対比させると、次の如くなる。

PMC の数は 2ⁿ の形で増して行くが、現在の所 n=4 なる種はみえていない。

大井の分類基準 (大綱)		種 例	花粉粒数
タデ属	一花柱の鉤曲する群 ①	<i>P. filiforme</i>	8
	①でなく	花が葉腋に東生、 穂(総)状花序ならず ②	<i>P. aviculare</i> 32
	②でなく	茎は花茎状で 分枝せず、花 穂頂生、1 個 ③	<i>P. viviparum</i> 32
	③でなく	茎に剛逆棘あり 攀縁性あり ④	<i>P. senticosum</i> 8
	④でなく		
	④でなく	茎に逆棘あり、攀縁性なし ⑤	<i>P. thunbergii</i> 16
	⑤でなく	穂(総)状花序をなす 茎は刺を有せず ⑥	<i>P. persicaria</i> (4) <i>P. nodosum</i> 8 <i>P. orientale</i> 32
	⑥でなく	茎は蔓性、花序著しく 分枝、雌雄同株又は 異株、円錐花序 ⑦	<i>P. multiflorum</i> 128
	⑦でなく	茎は直立、花序著しく 分枝、円錐花序、雌 雄異株 ⑧	<i>P. cuspidatum</i> 256
	⑧でなく		

Résumé

1. The number of pollen grains per pollen sac, the development of tapetum and archesporial cell were studied in some species of the genus *Polygonum*.
2. One archesporial cell arises from the hypodermal layer of the anther primordium.
3. The anther in this genus has always four pollen sacs, and a pollensac is surrounded with the four layers; epidermis, endothecium, transitional layer and tapetum.
4. The tapetum develops from the transitional layer. Nuclear division of the tapetal cell is a mitosis without the cytokinesis, at least in the first division.
5. Concerning the number of pollen grains, this genus can be classified into five types which contain 8, 16, 32, 128 and 256 pollen grains, respectively, in a pollen sac. Therefore, they have respectively 2, 4, 8, 32 and 64 pollen mother cells, and the pollen mother cells of the former three types are usually arranged in row in a pollen sac.
6. It seems to be probable that in *Polygonum persicaria* a pollen sac contains only four pollen grains.

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花粉の生理学的研究 XI

柱頭と花粉中におけるでんぷんと糖について*

岩 波 洋 造**

Yozo IWANAMI**: Physiological Researches of Pollen XI. Starch Grains and Sugars in Stigma and Pollen.*

1956 年 9 月 5 日受付

前報^{1,2)}において花粉粒中の炭水化物の変化とそれに関与する酵素作用の一部について述べ、また、花粉が人工培養中に外から吸収する糖の種類について報告した。今回は自然の状態で花粉が発芽を行う場である花の柱頭中におけるでんぷん粒の変化、糖の種類、及び花粉が培養基上で吸水後に自己の中に形成するでんぷん粒について観察した結果を報告する。

I. 柱頭中のでんぷん粒と糖

花の開花の度と柱頭や花粉の熟度とは、必ずしも平行せずにむしろ少しずつずれる場合が多いが、ここでは開花の度を大よその基準として調査を行った。

実 験 1

花の柱頭の組織を細切片としてスライドグラスにとり、ヨード抱水クロラル液で処理してでんぷん粒の有無を鏡検した。結果は花の生熟の極めて初期にはでんぷん粒はみられないが、次第に柱頭内に充満し、やがて開花の時期が近づくにつれて、でんぷん粒は急激に減少して遂には殆んどその形がみられなくなった。

Fig. 1 の写真は *Lilium longiflorum* Thunb. の柱頭中でのでんぷん粒の消失の様子を示している。この中、下段の3葉は上段の○印の部分拡大したもので、黒く、円く見える一粒一粒がでんぷん粒である。でんぷん粒がもっともおそく迄残るのは、

内壁の組織と、通導組織 (Fig. 1 の 1, 2 の写真で灰色にみえる) の外傾の部分で、もつとも早く消失するのは花柱の外皮に近い部分であった。また通導組織のみは、花の成熟の全過程を通じてでんぷん粒の存在はみられなかった。これと同様の傾向は、*Lilium* の他の種類の柱頭、及び *Gladiolus*, *Antirrhinum*, *Hibiscus* などの柱頭についても観察された。

これらのでんぷん粒の急激な消失は、柱頭自身の生長にも多少は使われるであろうが、前述のごとく花粉が生長時に外から糖を吸収している事実と共に、開花時の柱頭に糖類が貯えられていることを示唆している。これに関しては志佐氏³⁾らが、柱頭をも含めたベチュニヤの雌ずいに sucrose, glucose, fructose の糖が存在することを報告している。

実 験 2

i) *Lilium longiflorum* Thunb., *L. auratum* Lindl., *Gladiolus gandavensis* Van Houtt., *Calystegia hederacea* Wall., *Antirrhinum majus* L., *Camellia japonica* L., *Hibiscus mutabilis* L., などの柱頭 0.2 g を別々に乳鉢にとり、80% アルコール 1 cc ずつを加えてすりつぶし、更に 1 cc ずつのアルコールを加えてよく攪はんした後、遠心分離器にかけて上澄液を小型の蒸発皿にとった。これを 50°C の乾燥器中で一たん乾燥させた後に、0.2 cc の無水ピリジンで溶かし直して

* 文部省科学研究助成金による研究の一部である。

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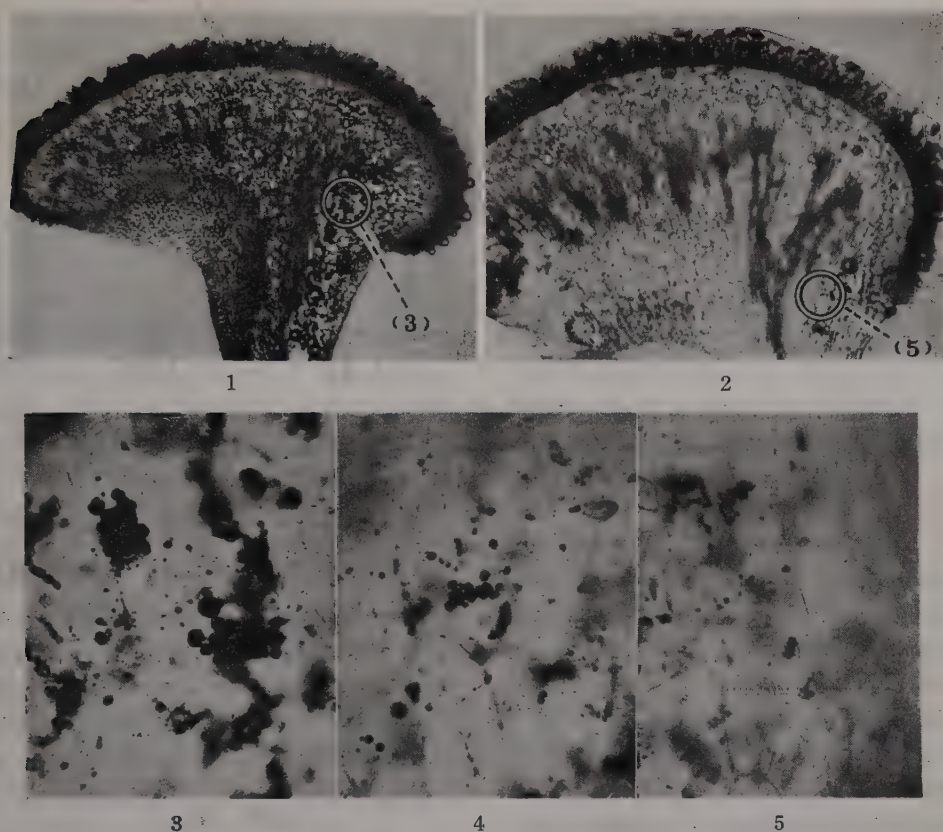


Fig. 1. *L. longiflorum* Thunb. の柱頭内のでんぷん粒。

1—蕾 (開花4日前) の柱頭 2—開花1日後の柱頭

3—1の部分拡大 4—開花1日前 5—2の部分拡大

から、直接濾紙に 0.06 cc ずつ与えてクロマトグラフの実験の系列に移した。展開方法、呈色剤などは前の実験⁽¹⁾の通りである。25~27°C で 20 時間展開後に得られたクロマトグラムが Fig. 2 に示されている。

即ち sucrose, glucose fructose の 3 種類の糖は何れの柱頭にも必ず存在しているが、sucrose が多くて glucose, fructose の少ないもの、sucrose が比較的少くて glucose, fructose の多いもの、これらのもの以外の糖をも含むものなどに大別できるようであった。

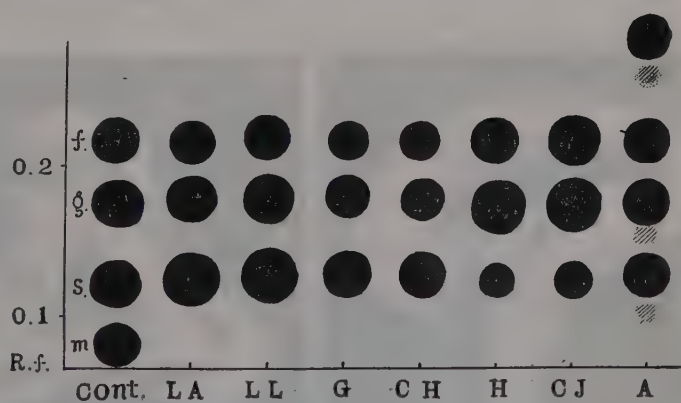


Fig. 2. 花の柱頭に含まれている糖

LA—*Lilium auratum* Lindl., LL—*Lilium longiflorum* Thunb., G—*Gladiolus gandavensis* Van Houtt., CH—*Calystegia hederacea* Wall., H—*Hibiscus mutabilis* L., CJ—*Camellia japonica* L., A—*Antirrhinum majus* L.
(f—fructose g—glucose s—sucrose m—maltose)

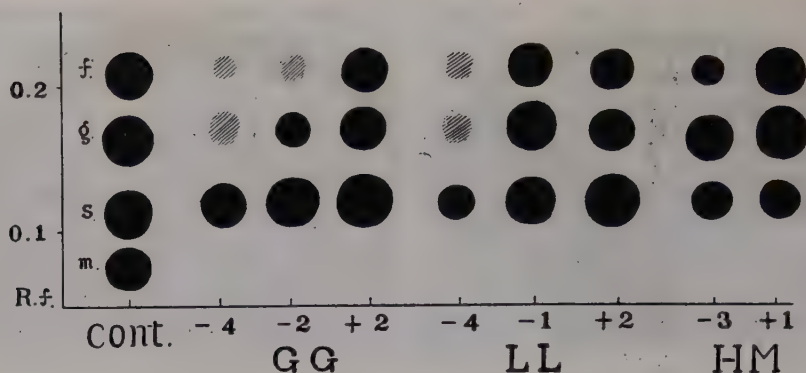


Fig. 3. 花の成熟にともなう柱頭内の糖の変化

GG—*Gladiolus gandavensis* Van Houtt., LL—*Lilium longiflorum* Thunb.,
HM—*Hibiscus mutabilis* L. (—は開花前, +は開花後, 数字は日数を示す)

ii) 上の実験は何れも開花時の柱頭について行ったものであるが, 次に生育の時期による糖の変化を上同の方法で調査した。*Gladiolus gandavensis* Van Houtt., *Lilium longiflorum* Thunb., *Hibiscus mutabilis* L. について調べられた結果が Fig. 3 に示されている。

結果は sucrose は蕾の時期から存在しているが, 次第にその量を増すとともに, glucose, fructose が急激に増加している。一方これらの glucose などは開花時に sucrose に移行するごとき様子が *Lilium* の柱頭で観察された。なお柱頭の場合も花粉と同様に, maltose の存在はみられなかった。

II. でんぶんの分解合成に関する酵素の存在。

上述の観察のようなでんぶん ↔ 糖の変化が柱頭内で行われているとすれば, 少なくともそれらの組織の中に amylase, phosphorylase などの酵素の存在がみられる筈である。これを確かめるために次の実験を行った。

実 験 3

i) 3%の可溶性澱粉を含めた寒天板(寒天1%)を1mmの厚さにしてスライドガラスの上にとり, この上に柱頭, 及びその近くの花柱の組織の細切片(約0.5mmの厚さ)をのせる。このよう

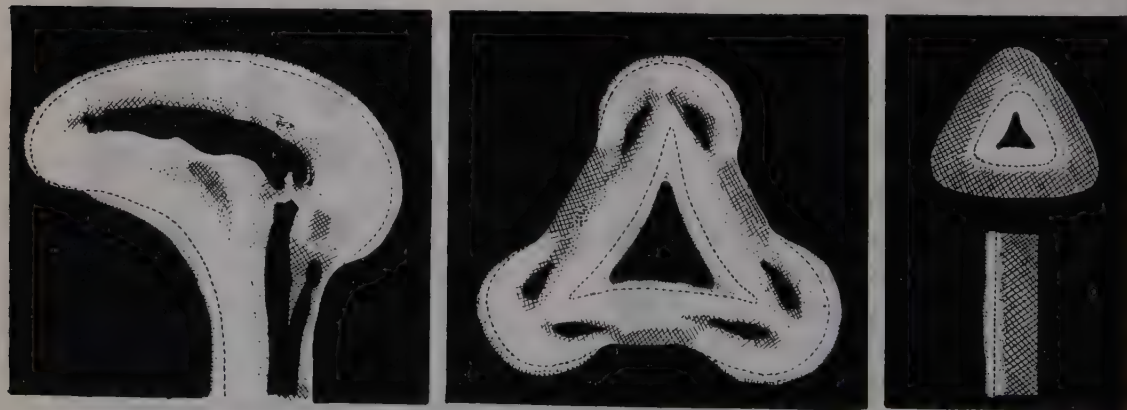


Fig. 4. でんぶん分解力の部分的な違いを示す。(L. longiflorum Thunb.)
黒—分解力のない部分, 斜線, 点部—分解力の弱い部分, 白—分解力の強い部分

にしたものをスライドガラスとともに 28°C の湿室に納め、30 分後に組織片をとり除いて、ヨード液に浸した濾紙で寒天の上面を軽くぬぐい、ヨード反応の強さを解剖顕微鏡で観察した。これはヨード反応が見られなかったり、他の部分より薄れたりしている部分がもしあれば、その部分の寒天板中にあったでんぷんが分解されたと考えられるからである。

Fig. 4 は *Lilium longiflorum* Thunb. の柱頭の横断面、縦断面、花柱の横断面、縦断面のそれぞれの面が接していた附近の寒天のヨード反応を示している。これによって通導組織にはでんぷんの分解力はなく、柱頂細胞、内壁の組織(誘導組織)の部分に強い分解力を有することが推定される。これらの作用は酵素、特に amylase の働きによると考えられるが、これを確かめるために、次にでんぷんを与えて新たに作られる糖の種類を調べた。

ii) 0.8% の可溶性でんぷん液 3 cc (pH 6.5) の中に、*Lilium longiflorum* Thunb. の柱頭 0.4 g を入れてすりつぶし、遠心分離器にかけてった上澄液を 28°C の湿室に納めた。さらにこれと同様のものを 2 つ作り、1 つは一たん熱を加えて煮沸した後、また他の 1 つはヨード反応の変化をみるためにそのまま同様の湿室に納めた。

時間の経過と共にこの液を 0.04 cc づつ濾紙にとってクロマトグラフの方法で糖の生成を調べた。またこれと平行して液のヨード反応を観察した。これらの結果が表 1、及び Fig. 5 に示されている。

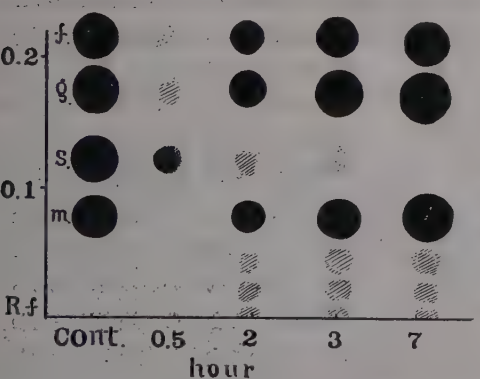


Fig. 5. 可溶性でんぷん液に柱頭組織汁を加えた時の糖の生成
f.—fructose g.—glucose
s.—sucrose m.—maltose

表 1. 柱頭の組織汁を加えた時の可溶性でんぷん液のヨード反応

時間	1/6	1	2	3	5	8	8 (boil)
色	青	青紫	褐紫	黄褐	黄	薄黄	青

結果はでんぷんが次第に消失するとともに、maltose、及び glucose、fructose などの糖が新たに形成されることを示している。また一たん煮沸したものでは最後まででんぷんが残り、新たな糖の形成もみられなかった。これらの結果、及び実験 1 の観察の結果をみると、柱頭中に amylase が存在していてでんぷんを糖に分解する際に働いていると考えてよいと思われる。

実験 4

ごく若い柱頭組織にでんぷん粒が形成されることは phosphorylase の存在を暗示するが、この酵素について次の 2 つの実験を行った。

i) Cori-ester (G-1-P) を 0.8% の割合に含む寒天板 (寒天 1.5%, pH 6.5) を作り、実験 3 の i) と同じような方法で phosphorylase の存在をみた。即ち前の場合とは反対に、組織片をのせた部分の寒天がヨード反応で青色に染っていれば、そこにでんぷんが形成されたと考えたものである。

結果は柱頭内の部分的な差違は明らかではなかったもので、大よそのヨード反応の強さを +, +, +, 及び - で示し、その結果を表 2 にあげた。

表 2. Cori-ester を含む寒天板に柱頭組織をのせた時のヨード反応

	柱 頭	同(熱処理)	花 柱
4 時間後	+	-	-
8 時間後	++	-	+

ii) Cori-ester を 0.5% の割合に蒸溜水 (pH 6.5) に溶かした液を秤量びんに 3 cc とり、この中にでんぷん粒を殆ど失った *Lilium longiflorum* Thunb. の柱頭の細切片を入れた。28°C に保って 4 時間、8 時間を経過する時に、ヨード抱水クロラル液で切片を処理して澱粉の再合成される様子を観察した。その結果が表 3 に示されている。

表 3. Cori-ester の液中でみられるでんぷん粒の形成

	柱 頭	通導組織	花 柱
2 時間後	—	—	—
4 時間後	+	—	—
8 時間後	++	—	+

新たに形成されたでんぷん粒は、以前に蕾の時期にみられたものに比較して可成り小粒で、その量も以前のように細胞全体に充満するには至らなかった。また核の周囲にのみでんぷん粒が密集して形成されている細胞が少なからず観察された。

III. 培養中に形成される花粉粒内のでんぷん粒

Impatiens の花粉が外部から糖を吸収してでんぷん粒を形成することについては既に述べた⁽⁴⁾が、これとは別に *Lilium* の花粉が吸水後に急激にでんぷん粒を形成する現象を示すので一応こゝに報告しておく。

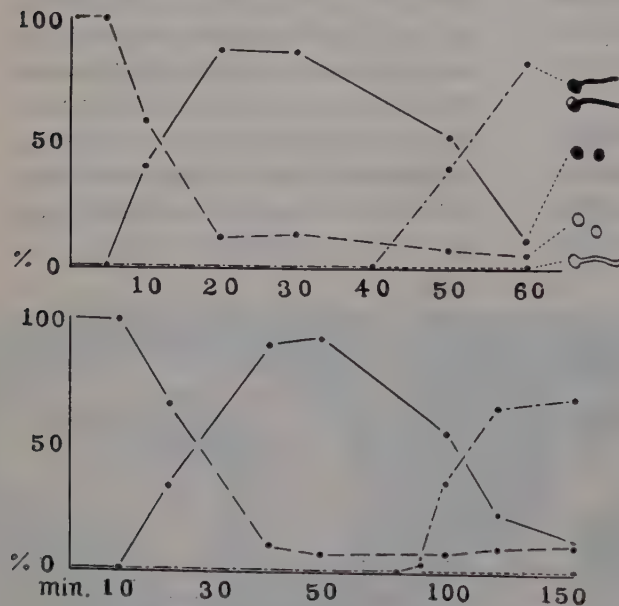


Fig. 6. 花粉の発芽とでんぷんの形成
上段—*Lilium auratum* Lindl.
下段—*L. longiflorum* Thunb.

- 不発芽、澱粉粒有
- 不発芽、澱粉粒無
- · - · 発芽、澱粉粒有
- 発芽、澱粉粒無

実 験 5

sucrose 6%, 寒天 1.5%, pH 6.5 の培養基に *Lilium* の花粉を撒布し、28℃ の温室に納めた。時間の経過とともにこの上から少しずつ花粉をとって、一たんカルノア液で固定後にルゴール液で処理してヨード反応を調べた。顕微鏡下で光を横からあて、黒褐色に染った花粉、及び黒褐色の部分が黄色乃至赤色に染って見える部分より多い花粉をでんぷん粒の形成されたものとしてその数をかぞえた。Fig. 6 はその結果を百分率で示している。

開花時の花粉はでんぷん粒をもっていないが、培養基上に移されると急速にでんぷん粒を形成している。またこのでんぷん粒の形成は発芽前に行なわれ、でんぷん粒をもたずに発芽を行う花粉は全くみられなかった。このことは一見花粉が外から糖を吸収することと直接結びつくかにみられるが、これと同様の現象は xylose などの糖の中でもみられ (未発表)、この時期に花粉が自己のも

つ sucrose を glucose と fructose とに分解している⁽¹⁾ ので、この時のでんぷん粒の形成は、むしろ後述のとおり内部の糖の変化であると考えの方がよいと思われる。

しかしながら花粉は一般に無糖の培養基上では発芽を行わないし、この他、花粉が生長時に確かに外から糖を吸収すること^(2,7)、柱頭中に sucrose などの糖が含まれていること、花粉が自体の幾千倍に花粉管を伸した後もなお管中にでんぷん粒を保有していること、花粉は外液の濃度に合わせて滲透圧を調節していること⁽⁵⁾、及び *Impatiens*⁽⁴⁾、*Pinus*⁽⁶⁾、などの花粉は外から得た糖をでんぷん粉粒にかえて貯えることなどが知られているので、これらの現象を考え合わせて筆者は花粉の栄養について大よそ次のように考えている。花粉は自己の中に養分を貯えて葯からでてくるが、これらの貯蔵養分は主として受粉前の呼吸、及び受粉時の滲透圧調節に使われ、余

分のものは生長にも役立てられているが、受粉後は雌ずいから多量の糖を吸収している。しかもこれら外から吸収した糖は、一たんでんぷん粒として内に貯えられ、必要に応じて再び糖として生長に使われるものであろう。

たゞ花粉の種類によっては、でんぷん粒を初めから作らないもの（例 *Camellia* の花粉）もあるので、これらについてはさらに調査中である。

実験に協力された藤綱静子氏に感謝の意を表す。

Summary

- 1) The process of digestion of starch grains in the growing stigma of *Lilium longiflorum* Thunb. was observed and shown in Fig. 1.
- 2) In the immature stigma of *Lilium*, *Antirrhinum*, *Gladiolus* and *Hibiscus* storage starch grains were found abundantly, but with the progress of maturation the starch grains disappeared.
- 3) Sugars in the stigma of *Lilium* and some other flowers were investigated by means of paperchromatography. Sucrose, glucose and fructose were found to exist in the respective stigmas (Figs. 2, 3).
- 4) By the addition of stigma juice of *Lilium* to the solution of soluble starch, maltose, glucose and some other sugars were regularly detected, while the color of iodine reaction of this solution turned into yellow brown from blue (Fig. 5). It may be said that tissues of stigma contain some amylase.
- 5) The localization of amylase in stigma was histochemically investigated. The presence of amylase was demonstrated in all parts of the stigma tissue except vascular tissue, and the activity of the enzymes was found to be highest in the tip tissue and inductive tissue (Fig. 4).
- 6) The tissues of mature stigma of *Lilium* have an activity to produce starch grains from Cori-ester. It may be said that there exists some phosphorylase in these tissues.
- 7) In the mature pollen starch grains are deposited before germination when they are incubated on the sugar media, while germinating pollen which had been freed of starch grain was not found (Fig. 6).

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毬果の發育からみたスギ科の類縁關係

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Michiko HIDA*: The Comparative Study of Taxodiaceae from the Stand Point of the Development of the Cone Scale.

1956 年 9 月 10 日 受付

針葉樹の雌花は一般に毬花を形成し、受精發育して毬果となる。毬花は多数の鱗片からなり、その各々は内側の胚珠をつける部分とこれにかさなった外側の部分即ち実片と苞片とからなりたっている。雌花が受精すると各鱗片は發育をはじめるが、多くの場合苞片より実片の發育が著しく、又鱗片は木化してくるために毬果の鱗片即ち果片では雌花の鱗片と著しく形態が異なってくる。この様な雌花の鱗片に於ける実片及び苞片の形態や、これが發育に伴う変化及び果片の形態は植物の種類によって特異的であるので、スギ科植物の各々について比較し、これらの観点からスギ科内での *Metasequoia* の類縁關係を追求してみた。

材 料 及 び 方 法

材料はスギ科のコウヤマキ (*Sciadopitys verticillata*), コウヨウザン (*Cunninghamia lanceolata*), *Athrotaxis selaginoides*, *Taiwania cryptomerioides*, *Taxodium distichum*, *Glyptostrobus pensilis*, *Sequoia sempervirens*, *Sequoiadendron giganteum*, *Metasequoia glyptostroboides*, スギ (*Cryptomeria japonica*) の 10 種の雌花から果実迄の各段階のものを京都大学演習林, 京都大学理學部植物園, 其他で採集し, なまの材料の得られないものは腊葉標本, 或はアルコール漬標本を用いた。*Taiwania* と *Sequoiadendron* の雌花は入手出来なかったので文献で調査した (早田, 1933, Florin, 1951)。

採集した材料は 70% アルコール中に保存し, 外部形態をみる時にはこのまゝ用い, 内部構造, 特に管束の走向をみるには鱗片の手切切片を作り

フロログルシンと塩酸で染色するか, 鱗片をパラフィン切片法により切片としデラフィルドヘマトキシリンで染色し検鏡した。

観 察

1. コウヤマキ (*Sciadopitys verticillata*). (Fig. 1)

毬花は輪生葉をつけた枝の頂につき, 略々球形でその下部は多数の鱗片葉で包まれている。毬花の鱗片は約 15 片がらせん状に軸に着生し, 各鱗片は褐色を帯びた菱形で, 外側には薄膜で上部が裂片状になった苞片があり, 内側にはやゝ肥厚した扇形の実片がある。この 2 つの部分は上部では

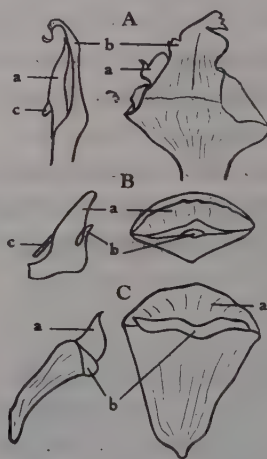


Fig. 1. Development of the cone scales of *Sciadopitys verticillata*. A: a flower scale $\times 8$, B: a young cone scale $\times 1.5$, C: an adult cone scale $\times 2$. left: A and B, longitudinal section, C, side view, right: outside view. a: ovuliferous scale, b: bract, c: ovule.

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重なり下部では癒着しているが、苞片は実片より長いために褐色の先端部は実片をしのぎ、内側即ち実片の方に曲っている。実片の内側には 5~9 個の胚珠が珠孔を軸の方に向けて着生する。

鱗片への管束は軸から分れた 3 つが木部を中心部に向けて輪状に配列し、その外側の 1 つは苞片に、他の 2 つは更に多数の管束に分かれて実片にゆく。実片の管束は胚珠の基部では胚珠にゆくものを分岐する。

花が受粉すると鱗片の内側の実片は肥厚伸長するが、外側の苞片の發育は余り著しくないために果実になると果片の大部分は扇形の実片よりなり、苞片は先端部だけ僅かに離れ他は実片の外側に癒着している。この場合管束も苞片のものより実片のものの方が伸長し実片の先端に到達している。

2. コウヨウザン (*Cunninghamia lanceolata*) (Fig. 2. A-C).

雌性毬花は枝端につき、径 10 mm 位の球形で基部は細い披針形の多数の葉で囲まれている。鱗片は三角形で外縁には鋸歯があり、内面の下部には 3 つの小さな突起即ち実片があって、これに胚珠が 3 つ珠孔を軸の方に向けて着いている。

受精後三角形の苞片は巾、長さを増し、次第に革質になるが、内側の小さな実片はあまり発達しない。従って果片では大部分が苞片で実片はその内側に小さな歯状突起として残存するに過ぎない。苞片は三角形の下部が細い柄となり殆んど直角に曲って果軸につく。

鱗片の管束は果軸から来たものが 3 つに分かれそのうち 1 個は実片に、2 個は苞片にゆくが、更に上部では実片のは 3 個に分かれて各実片に、苞片のは多数に分かれて巾広くなった苞片にひろがる。

3. *Athrotaxis selaginoides* (Fig. 2. D-F, Fig. 6. A).

雌花は多数の鱗片葉で囲まれて枝端につく。毬花を形成している鱗片は柄を持った三角形で先端は外方に反り、全体はスプーン状を呈している。三角形の内側の基部即ち柄との境目はやゝ肥厚しこゝにはほぼ直立に 2~5 個の胚珠をつける。軸よりの管束は鱗片の柄の下部では一部の欠けた輪状

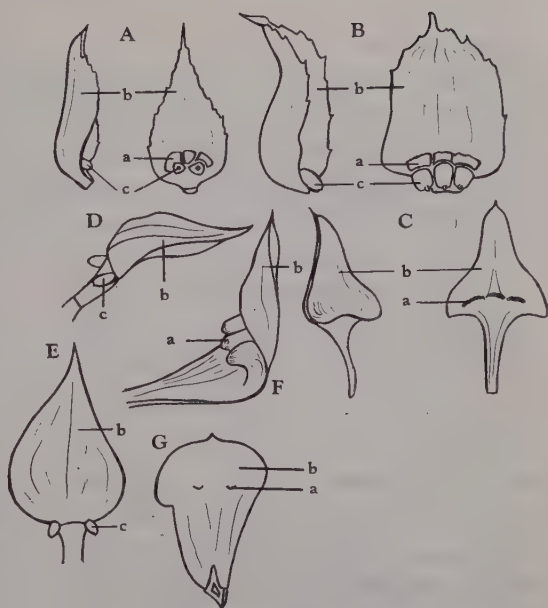


Fig. 2. Development of cone scales. A-C, *Cunninghamia lanceolata*. A: a flower scale $\times 8$, B: a young cone scale $\times 5$, C: an adult corn scale $\times 3$, left: side view, right: inside view. D-F, *Athrotaxis selaginoides*. D: a flower scale (side view) $\times 15$, E: a flower scale (inside view) $\times 15$, F: an adult cone scale, seeds removed (side view) $\times 5$, G: a flower scale of *Taiwania cryptomerioides* (inside view) $\times 10$. a: ovuliferous scale, b: bract, c: ovule.

をしているが上部にゆくに従って内側に 2 個、外側に 3 個に分かれ、更に上部では内側の 2 個は 3 個になって柄の上部の肥厚部に達し、外側の 3 個は多数に分かれて鱗片の上部即ち三角形の苞片にゆく。従って柄と三角形の部分との境の肥厚部が実片と考えられる。

鱗片は發育にともない苞片の部分が著しく発達し、大きな三角形になりその下部は細い柄ではほぼ直角に曲っている。苞片の内側には柄の肥厚部の発達した乳頭状の実片があって、こゝに種子をつける。種子は胚珠の場合より 90 度余り回転し珠孔は軸の方に向いている。

著者の観察したのは *Athrotaxis selaginoides* であるが、他の二種 *A. laxifolia* Hook., *A. cupressoides* Don では更に実片が上方迄発達し後者では苞片の先端よりも前面に突き出て楯状となる

(Florin, 1951)。

4. *Taiwania cryptomerioides* (Fig. 2. G)

雌花に就いては観察出来なかったが、毬果は長径約1cmの楕円体で枝端につく。各果片は革質で扇形を呈し内側に2個の種子をつけているが、その附着点は痕跡的な突起になっている。この突起は実片の非常に発達した悪いものと考えられる事が出来る。従って果片の大部分は苞片である。

5. *Taxodium distichum* (Fig. 3. A-C, Fig. 6. B)

雌花は肉質の鱗片よりなり、径約4mmの球形で枝端に雁首状に曲って着く。各鱗片は菱形で

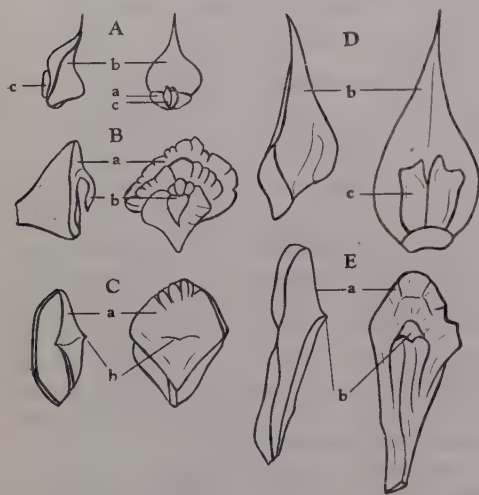


Fig. 3. Development of cone scales.

A-C, *Taxodium distichum*. A: a flower scale $\times 13$, B: a young cone scale $\times 6$, C: an adult cone scale $\times 2$. D-E, *Glyptostrobus pensilis*. D: a flower scale $\times 30$, E: an adult cone scale $\times 6$. left: side view, right: A and D, inside view, B, C and E, outside view, a: ovuliferous scale, b: bract, c: ovule.

細く尖った先端は外方に反り、下部程肉厚になっている。肥厚した下部の内面には先端が3~4片に分かれた薄い舌状の小突起がある。これは実片で雌花の發育にともなって次第に伸長肥厚し、花時に鱗片の大部分を占めていた肉厚の苞片をしのいで発達する。従って若い毬果では前面からみると扇形の実片の外側に苞片の先端部が舌状についている。更に毬果が熟すると全体が球形となり、各果片は木化しその内側に三角柱状の2個の種子

を蔵する。そして果片の大部分は実片によって占められ苞片はその外側に癒着し先端だけが僅かに隆起して楕円状の実片の外側に上下に割る線としてあらわれる。

鱗片の管束は花時には苞片のものだけよく発達し、実片へゆくものは鱗片の基部に来ているが実片の発達とともによく伸長し果実では苞片のものより長くなる。

6. *Glyptostrobus pensilis* (Fig. 3. D-E, Fig. 6. C)

雌花は *Taxodium* と同様に枝端にやゝ雁首状に曲って着生するが、小さな葉状の鱗片からなるために新芽と区別し難い。各鱗片は披針形で先端は尖がり、下部は外方にふくらみ、その内側に直立した2個の胚珠をつけている。胚珠の基部はやゝ肥厚しているが、毬果の發育に伴い上方に伸長する。この肥厚部が実片で鱗片の大部分は苞片に他ならない。実片は更に発達し成熟果では苞片より長くなり苞片はその外側に萎縮した先端を残し下部は癒着している。この様な実片と苞片からなる果片は細長い菱形で20個余りが集まって紡錘形の毬果を形成している。

鱗片の管束の発達も実片と苞片の消長とよく一致し、花時には苞片の管束がよく発達しているが其後実片の発達につれてこれの管束が伸長をはじめ果片では苞片のものより長くなる。

7. *Sequoia sempervirens* (Fig. 4. A-C Fig. 6. E)

雌花は多数の鱗片に囲まれて枝端につき、若いものでは新条と同じ様な外観を呈している。大きさは約4mmで雌花を構成している鱗片は鼻形をなし、先端は細く尖がり下部内面は肥厚しここに6~9個の胚珠が珠孔を上に向けて着生している。この肥厚部は実片に相当する部分で發育に伴い肥厚すると同時に上方及び外方に伸長し、鼻形の苞片の先端をしのいで上方外方に突出する。一方、苞片は下部のみ外方に突出し、先端部は殆んど伸長しないために鱗片は巾広い菱形となり、その上半分は実片の肥厚部で、下半分は実片とこれの外側に癒着している苞片の肥厚突出したもので、その中央部に針形の苞片の先端をつけている。更に發育が進むと上、下部の突出は更に著しくなり、巾広い菱形は唇形に変化し、中央部のくぼみに苞片の先端を極く僅か残している。この場合実片からなる上唇の方が、実片苞片の合体した下唇より大きい。

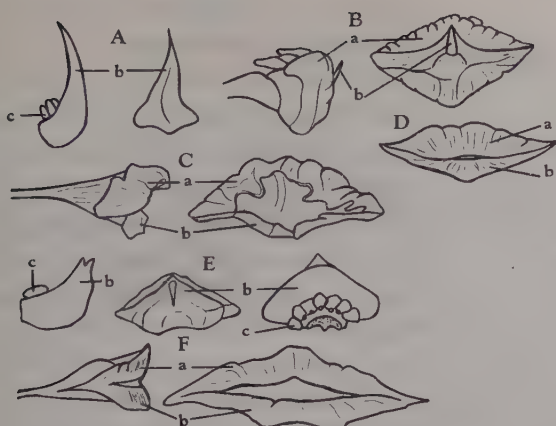


Fig. 4. Development of cone scales. A-C, *Sequoia sempervirens*. A: a flower scale $\times 15$, B: a young cone scale $\times 7$, C: an adult cone scale $\times 5$, left: A, longitudinal section, B and C side view, right: outside view, D: an adult cone scale of *Sequoiadendron giganteum* (outside view) $\times 2$, E-F, *Metasequoia glyptostroboides*. E: a flower scale $\times 8$, left: longitudinal section, middle: outside view, right: inside view. F: An adult cone scale $\times 7$, left: side view, right: outside view. a: ovuliferous scale, b: bract, c: ovule.

この様な發育過程を追って管束の状態をみると雌花では花軸から分かれた管束の1部は鱗片の先端にゆき、他は胚珠のもとにとまっているが、実片の發育に伴い後者は苞片のものと同様によく發育し、実片の先端に到達する。

胚珠は最初珠孔を上方向にしているが、実片の上外方への突出と共に次第に果軸の方に向きを変え、成果では正しく珠孔は果軸の方を向く。

8. *Sequoiadendron giganteum* (Fig. 4, D)

毬果は *Sequoia* より遙かに大きく長径約 50 mm の楕円形で、各果片は *Sequoia* と同様に唇形をしている。雌花及び發育の種々の段階の幼果は得られなかったが、文献 (Florin, 1951) によれば *Sequoia* と全く同様な發育過程を辿っている。

9. スギ (*Cryptomeria japonica*) (Fig. 5. A-C, Fig. 6. F)

毬花はこれを構成する鱗片より長い多数の葉に囲まれ、径約 4 mm で略球形をしている。各鱗片

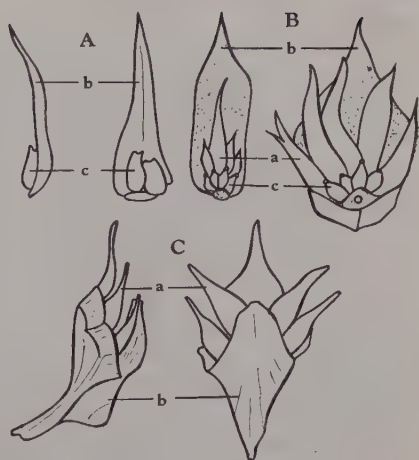


Fig. 5. Development of cone scales of *Cryptomeria japonica*. A: a flower scale $\times 10$, left: side view, right: inside view, B: two stages of young cone scales $\times 10$, C: an adult cone scale $\times 6$, left: side view, right: outside view. a: ovuliferous scale, b: bract, c: ovule.

は長三角形で先端は鋭く尖がり、その基部内側に直立した 2~5 個の胚珠がついている。

毬花が發育するにつれて鱗片即ち苞片の内側の胚珠との間から実片が發育をはじめる。受精後間もないものでは実片の突起は胚珠より小さいが、やがて胚珠を越し更に苞片をこえて伸長する。しかしこの場合 *Taxodium* 等にみられる様な苞片と実片の完全な癒着はなく唯下部だけで癒着し上部では遊離している。又苞片の先端は果片になっても合一することなく数片に分かれている。

この様な実片の發育に伴って花時余り發育していなかった実片の管束も苞片のものと共に發育し、数個に分かれて各裂片の先端にゆく。

直立胚珠は種子になっても向きを変えず、常に珠孔を上方向にしている。

10. *Metasequoia glyptostroboides* (Fig. 4, E-F, Fig. 6. D)

毬花は本邦 (京都) では 3 月末頃枝の先端近くに短い柄で着生し、大きさは約 7 mm の楕円形で、柄には鱗葉がある。雌花の鱗片は約 20 片で軸に對生している。この着き方はスギ科の他のすべてのものがらせん配列しているのに対して著しく異

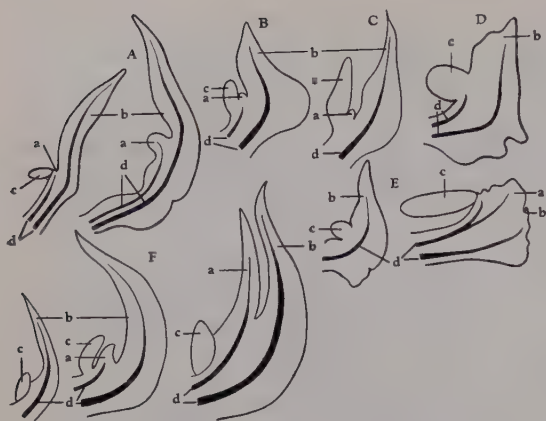


Fig. 6. Longitudinal sections of cone scales, A: *Athrotaxis*, left: a flower scale $\times 15$, right: an adult cone scale $\times 8$. B: A flower scale of *Taxodium* $\times 25$. C: A flower scale of *Glyptostrobus* $\times 30$. D: A flower scale of *Metasequoia* $\times 30$. E: *Sequoia*, left: a flower scale, $\times 25$, right: a young cone scale $\times 10$, F: *Cryptomeria* $\times 15$, left: a flower scale, middle and right: two stages of young cone scales. a: ovuliferous scale, b: bract, c: ovule, d: vascular bundle.

るところである。各鱗片は菱形に近い五角形で肉厚、その内側に4~9個の胚珠が珠孔を略々花軸に向けて着く。断面でみると鱗片の外側面に大きな樹脂腔があり、この内側に数個の管束が樹脂腔の周囲に沿って木部を内方にして（樹脂腔と反対側に向けて）配列している。もう一群の管束は木部を外にして、即ち前記の管束と木部と向きあって胚珠の基部に達している。この事から鱗片の上部は苞片で内側の胚珠の附着部が実片と考えることができる。毬果の果片は *Sequoia* と同じく唇形である事から推して、実片は毬果の發育に伴って伸長と同時に前面に突出し、苞片は実片と癒合したまま下部が突出して先端を僅かに凹所に残しこのような唇形の果片になるものと思われる。実片の發育につれてこれの管束も伸長し果片では苞片及び実片にゆく管束が認められる (Sterling, 1949)。

考 察

1. 毬果の發育過程からみたスギ科植物の分類

以上の観察でわかるようにコウヤマキでは実片とこれより長い苞片とからなる雌花の鱗片は受精後の發育によって実片が苞片よりよく発達し、果

片では長い実片の外側に短い苞片が先端だけを僅かに残して下部は癒合している。ところがコウヨウザンでは花に於いては大きな苞片の内側に舌状の小さい実片をみるが其後も実片の發育は弱く苞片の生長の方が遙かに著しいために、果片では大部分が苞片で、実片はその内側に小さい歯状突起として残るにすぎない。このような發育過程は *Athrotaxis selaginoides* にもみられ、この場合は実片がコウヨウザンよりやゝよく發育して乳頭状突起になる。同属の *A. laxifolia*, *A. cupressoides* では実片が更によく發育して *Taxodium* に近い状態を示している。又、苞片だけからなるようにみえる *Taiwania* の果片もコウヨウザンと同じく苞片が著しく発達し、実片がコウヨウザンの場合以上に發育の悪いものと考えられる事が出来る。

次に *Taxodium* 及び *Glyptostrobus* ではどちらも花時には辛うじて苞片から実片を区別出来る程度であるが、發育につれて実片が苞片と癒合したまま著しく発達し苞

片をしのいで伸長する結果、果片は楕状となり、苞片はその先端だけを僅かに残し実片の附属物のような状態になる。それが *Sequoia* では実片の發育は更に著しく上方に伸長するだけでなく前方にも突出し、又、下部に於いては苞片を外部に癒合したまま前方に突き出してくるために果片は唇形となる。*Metasequoia*, *Sequoiadendron* についてはその發育過程を追ってみることが出来なかったが、これと同じ過程をたどるものと思われる。

最後にスギであるが、これは前記の何れとも少し異り、花時には実片、苞片の区別は出来ないが、發育に伴って実片が發育してくる。この点は *Taxodium* 等と似ているが、その伸長が後者の様に苞片に癒合したままではなく、基部だけで癒合し、他は遊離して伸長し、先端部は数片に分かれている。従って果片では大きな菱形の苞片とこれよりも長く伸長し、先端の数片に分かれた実片がみられる。

この様に同じスギ科に属するものでも実片、苞片の發育程度は区々であるから、雌花の実片及び苞片の形とそれの發育に伴う変化からスギ科をながめると次の5群に分けることが出来る。

第1群：雌花及び毬果のいずれの鱗片に於いても明らかに実片と苞片の区別の出来るもの。コウヤマキ (*Sciadopitys*)

第2群：雌花では実片、苞片の区別は出来るが成熟に伴い苞片のみ発達し、毬果では実片が殆んど痕跡的となるもの。コウヨウザン (*Cunninghamia*), *Taiwania*, *Athrotaxis*.

第3群：雌花ではわずかに実片と苞片の区別出来るが、成熟に伴い実片が著しく発

達し毬果では苞片が実片の外側に癒着しているもの。 *Taxodium*, *Glyptostrobus*.

第4群：雌花及び毬果の何れにおいても実片、苞片の区別は明らかでなく、雌花の鱗片の大部分は苞片で、成熟に伴い実片が著しく発達し毬果では苞片は全く実片の附属物のような状態になるもの。 *Sequoia*, *Sequoiadendron*, *Metasequoia*.

Table 1. Grouping of Taxodiaceae represented by three criteria.

Criteria Genera	Number of the protoxylem in roots (Hida, 1952)	Form of tracheids (Hida, 1953)	Development of the cone scales
<i>Sciadopitys</i>	1st group short root 2 long root 2	1st group length (av.) 1900-2400 μ bordered pit row 1-2 arrangement op>al	1st group Fig. 1
<i>Cunninghamia</i>			2nd group
<i>Taiwania</i>			Fig. 2
<i>Athrotaxis</i>		2nd group	
<i>Taxodium</i>	2nd group short root 2,3 long root 3-8	length (av.) 2200-2500 μ bordered pit row 1>2 arrangement op, al	3rd group Fig. 3
<i>Glyptostrobus</i>			
<i>Sequoia</i>		3rd group length (av.) 3700-4700 μ bordered pit row 1-3 arrangement op	4th group Fig. 4
<i>Sequoiadendron</i>			
<i>Metasequoia</i>			
<i>Cryptomeria</i>	3rd group short root 3 long root 3	4th group length (av.) 2800 μ bordered pit row 1>2 arrangement op>al	5th group Fig. 5

第5群：雌花の鱗片は苞片のみで実片を区別する事は出来ないが、成熟に伴い実片が苞片を越して伸長し、その先端が5~7裂しているもの。スギ(*Cryptomeria*)。

猶、スギ科に近いマツ科のものは何れも花、果実のどちらの鱗片に於いても実片、苞片の区別が明らかで、スギ科ではコウヤマキに近い。又、ヒノキ科の鱗片は *Sequoia* 等の第4群に属するものと比較的よく似ている。これらの事はスギ科と他科との類縁関係を物語るものと思われる。

2. 他の形態からみた分類との比較

上記の毬果の發育過程からみたスギ科植物の分類を以前にしらべた根の原初木部数(肥田 1952)及び仮導管の形態による分類(肥田, 1953)と比較したのが別表(Table. 1.)で、こゝにみられる様に、根の原初木部数及び仮導管の形態による分類に於いて第1群とした、コウヤマキ、コウヨウザン、*Taiwania* のうち毬果による分類ではコウヤマキが第1群に、後の二者は第2群に属している。*Athrotaxis* の根についての観察はないが、仮導管の形態では *Taxodium*, *Glyptostrobus* と同じ群に入れられるが、この事は毬果に於いても第2群と第3群の間と考えられる点と一致するものである。又、根では第2群として *Taxodium*, *Glyptostrobus*, *Sequoia*, *Metasequoia*, *Sequoiadendron* を包含しているが、仮導管の形態によって更にこれが2つの群即ち、*Taxodium*, *Glyptostrobus* の1群と *Sequoia*, *Metasequoia*, *Sequoiadendron* の群に分けられ、これはそのまま毬果からみた分類にもあてはまるものである。最後のスギについては根に於いても、仮導管の形態に於いても他のものとは別の群に分けられたが、今度の場合も第1~第4群と別に第5群として分ける事が出来る。又、引田氏の研究(引田, 1955)になる葉の構造からみた分類や長谷川氏の接木に関する研究(長谷川, メタセコイア保存会総会での講演, 1956)からも同様の結果が得られた。

この様に何れの分類の場合でも *Metasequoia* は *Sequoia*, *Sequoiadendron* と同一群に属し、この三者は非常によく似ている事を示している。(三木, 1954)。

要 約

1. 毬果の發育過程からみてスギ科を5群に分ける事が出来る。

2. この分類は以前にしらべた根の原初木部数及び仮導管の形態からみた分類とよく一致すると共に葉の構造による分類や接木に関する研究結果ともよく符合する。

3. 何れの分類に於いても *Metasequoia* はスギ科の内 *Sequoia*, *Sequoiadendron* と同一群に属する。

本研究に関し終始御懇切な御指導をたまわった大阪市立大学教授三木茂博士並びに材料採集にあたって種々御援助頂いた京都大学農学部演習林の長谷川勝好氏に厚く御礼申し上げます。

Summary

This paper deals with a comparative study of the development of female cone scales in Taxodiaceae with special reference to the affinity of *Metasequoia*.

The results can be summarized as follows:

1. Taxodiaceae are divided into 5 groups according to the development of cone scales.

1st Group; Bract and ovuliferous scales of both the flower and the adult cone can easily be distinguished each other at outward appearance. *Sciadopitys*.

2nd Group: Bract scales are distinguishable from ovuliferous scales in flower, but not in adult cone. There are found bract scales only, ovuliferous scales being undeveloped in adult cone. *Cunninghamia*, *Athrotaxis*, *Taiwania*.

3rd group: Bract scales are barely distinguishable from ovuliferous scales in flower, and the ovuliferous scales grow much larger than the bract ones later. The bract scales of the adult cone are fused to the ovuliferous scales.

..... *Taxodium, Glyptostrobus.*

4th Group: Bract and ovuliferous scales in either flower or adult cone cannot be distinguished each other. The ovuliferous scales grow remarkably afterward. The scales of adult cone develop into labial form: the upperlip implies the ovuliferous scale, the underlip the complex of the ovuliferous scale and the bract. The tip of the bract is barely noticeable in the center of the lip..... *Sequoia, Sequoiadendron, Metasequoia.*

5th Group: Flower scales consist of only bract scales, but after the fertilization ovuliferous scales develop rapidly, become longer than the bract, and divide into 5-7 lobes at the apex..... *Cryptomeria.*

2. This classification coincides with the result of the number of protoxylem in roots (Hida, 1952), the form of the tracheid (Hida, 1953), and also based on the structure of leaves (Hikita, 1955.) (refer to Table 1)

3. In Taxodiaceae the affinity of *Metasequoia* is found nearly to be the same as that of *Sequoia* and *Sequoiadendron*.

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本 会 記 事

昭和 31 年度会計決算報告 (昭和 31 年 1 月から昭和 31 年 12 月まで)

収 入 の 部		支 出 の 部	
会 費	850,875	出 版 費	1,166,324
予 約 購 読 料	226,599	発 送 費	129,428
一 部 売	19,800	編 集 関 係 費	69,111
バックナンバー売上金	213,430	図 書 関 係 費	39,680
別 刷 代	124,479	庶 務 関 係 費	107,176
文部省刊行補助金	200,000	大 会 関 係 費	53,760
小倉記念会よりの出版補助金	100,000	支 部 補 助	10,000
利 子	4,527	幹 事 手 当	69,000
広 告 料	33,500		
小 計	1,773,210	小 計	1,644,479
前年度繰越金	257,010	次年度繰越金	385,741
総 計	2,030,220	総 計	2,030,220

本会会員 荒木英一氏は昭和 30 年 11 月 29 日死去されました。

本会会員 高木毅氏は昭和 31 年 8 月 4 日死去されました。

本会会員 友岡浩氏は昭和 31 年 12 月 20 日死去されました。

ここに報告し謹んで哀悼の意を表します。

日 本 植 物 学 会

報 告

故牧野富太郎氏の葬儀は去る 1 月 22 日青山斎場で行われ、その際本会から花環と弔辞を捧げました。

日本植物学会 75 周年記念大会 (第 22 回大会)

先に予告しました通り本年度の大会は、10 月 12 日 (土)~14 日 (月) に東京大学教養学部で一般講演を行います。

一般講演御希望の方は次の点を御承知の上御用意下さい。

申込票は 5 月号に添付します。

- 1) 申込期日 7 月 31 日までに必着するように講演者名、演題、幻燈の有無を申し込む。
- 2) 講演時間 一題 13 分以内とする。
- 3) 講演要旨 8 月 31 日までに具体的内容のものを送る。

なお一般講演は 200 余を予定していますので、申込が非常に多数の場合にはお断りすることがあるかもしれません。

朝日科学奨励金について

朝日新聞社から朝日科学奨励金候補研究の募集について推薦の依頼がありましたので、会員各位の中で適当と思われる研究がありましたら 3 月 15 日までに学会会長宛御推薦下さい。

Decrement of Photoperiodic Stimulus in Transmission in *Pharbitis Nil*

by Shun-ichiro IMAMURA* and Atsushi TAKIMOTO*

今村駿一郎*・滝本敦*: 伝達に際してのアサガオ日長刺激の減衰

Received August 29, 1956

Introduction

In many short day plants a certain—for a given species a definite—number of photoperiodic cycles consisting of relatively short light periods and relatively long dark periods should be given in consecutive order to cause flower initiation (3, 8). Even if the photoperiodic cycle is an adequate one, short days less than the number required have no morphogenetic influence upon the growing point. The effects of two short days, which are given separately by inserting one long day between them, do not add up. The stimulus received on the preceding short day is annulled or dissipated on the succeeding long day. The disappearance of the stimulus may occur in every organ, stem, petiole and leaf blade. It is also conceivable that it may be a naturally occurring phenomenon and that the stimulus may be dissipated to some extent and decrease in intensity in transmission. In the experiments reported here it was endeavored to learn if the stimulus decreases on its passage through the stem.

Material and Methods

The principle of the method employed was based upon the following considerations. Should no decrease of stimulus occur on its way through the stem, a donor leaf subjected to a certain dark treatment would cause a similar flowering response in a receptor bud irrespective of its distance from the donor leaf. On the contrary, if this is not true, a difference in response would be detectable according to the distance between the donor leaf and the receptor bud. Flower initiation in the receptor bud on one branch of a two-branched plant induced by a donor leaf on the other branch, was compared with the response of a comparable bud induced by its subtending leaf.

To secure reliable results, the sensitivity of the donor leaf and the reactivity of the receptor bud of both experimental and control plants must be strictly com-

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parable. Therefore in this experiment two-branched plants were used, since on the two cotyledonary branches of equal vigor the corresponding leaves and buds may be supposed to have the same physiological disposition.

The material used was the *Pharbitis Nil* strain "Violet". Two-branched plants were obtained in the same way as in previous experiments (6). Both branches were topped above the second leaf. The second leaf on one branch served as donor and the second bud on the other as receptor; all other leaves and buds were removed.

Three lots of such plants were used in the experiment (Group I). One lot received one short day consisting of a 16 hour dark and an 8 hour light period. The other two lots received 2 and 3 short days respectively. Nine other lots of similar plants were used as control. On the two branches the second bud and its subtending leaf were left intact, therefore each plant had 2 receptor buds. Three lots (Group II) were given one, two and three short days starting on the same day as the experiment with group I. Three further lots were subjected to short day treatment in the same manner starting on the next day (Group III). A further day later the short day treatment of the last group (IV) was started.

In the experimental group the stimulus may have been delayed one or more days in arriving to the receptor bud (6), and the bud may have varied in sensitivity during this time. In order to investigate the change in sensitivity, 3 control groups were employed in which short day treatment was started after the lapse of a varying number of days from the beginning of the experiment. From the comparison of responses in these 3 control groups one could find the change in reactivity of the receptor bud after topping, under the assumption that the photoperiodic sensitivity of the donor leaf did not change.

The time in which the stimulus reaches the receptor bud in an experimental plant, can be estimated by comparing the position indicating number of the first flower primordium on its receptor shoot with that of the control plants, as reported in a previous paper (6). The "position indicating number" of the first flower increases with the increasing delay of the arrival of the stimulus at the receptor bud.

Results

Experiment 1. Dark treatment was started on June 21, and observations were made on July 14, 1954. The results are summarized in Table 1. In all plants the average number of flower primordia initiated increased with increasing number of short days given. In all control groups the same dark treatment had almost the same effect as revealed by the number of flower primordia initiated, indicating that no remarkable change in reactivity of receptor buds took place during the experimental treatment.

The response of the experimental group is in distinct contrast to that of the

Table 1. Decrease of stimulus on the way of transmission in the stem.

(Sown on May 7, transplanted on May 10, main axis removed on May 24, experiment started on June 21 and observation on July 14, 1954)

Group	No. of short days given	Length of stem between donor leaf and receptor bud + (length of petiole) in mm.	No. of flowering receptors / No. of receptors observed	No. of flower primordia		Position indicating number of the 1st flower primordium	Date of start of short day treatment
				Total	Average per receptor		
I	1	47.6+(79.7)	0/38	0	0.	—	June 21
	2	46.4+(76.8)	5/37	10	0.3±0.15	1.8±0.37	
	3	45.3+(77.4)	12/37	24	0.7±0.17	2.8±0.16	
II*	1	(68.5)	33/35	101	3.2±0.37	1.6±0.07	June 22
	2	(69.3)	34/34	160	4.7±0.38	1.8±0.11	
	3	(75.0)	33/33	218	6.6±0.46	1.9±0.10	
III*	1	(72.1)	29/31	98	3.2±0.35	2.5±0.09	June 23
	2	(70.2)	29/29	161	5.2±0.40	2.3±0.12	
	3	(69.6)	30/30	204	8.0±0.27	2.2±0.11	
IV*	1	(66.4)	31/32	112	3.5±0.40	2.9±0.12	June 24
	2	(67.5)	30/30	210	7.0±0.35	2.7±0.12	
	3	(67.7)	29/29	235	8.1±0.28	2.7±0.16	

* At the start, each plant had two receptor buds.

control groups. Plants, whose donor leaf and receptor bud were separated from each other by a stretch of the stem of ca. 4.6 cm, did not respond to a single short day but initiated flower primordia when 2 or 3 short days were given, though in far lesser number than the control plants, in which the subtending leaf of the receptor bud was the donor. After having received 3 short days all control plants, but only about one third of the experimental plants, produced flower buds. From these results it can be concluded that the stimulus becomes markedly weaker on its way while passing through the stem.

In control groups the position indicating number of the first flower increases with increasing delay of the start of short day treatment, indicating that more basal buds are determined as vegetative according to the length of the interval following the removal of the main axis. It is also noteworthy that within each control groups the position indicating number of the first flower is independent of the number of short days given. In the experimental group, however, the number increases with the number of short days given. Two short days induced the first flower on the 1.8th and three short days on the 2.8th node on the average. This may be due to the fact that owing to the decrease of the stimulus only a weak impulse reached the receptor buds in the plants which received two short days and flowering was induced only in the most sensitive individuals, but when the plants received another short day, more stimulus was transmitted causing flower initiation

Table 2. Decrease of stimulus on the way of transmission in the stem.
(Sown on May 8, transplanted on May 11, main axis removed on May 19,
experiment started on June 14 and observation on June 27, 1955)

Group	No. of short days given	Length of stem between donor leaf and receptor bud + (length of petiole) in mm.	No. of flowering receptors / No. of receptors observed	No. of receptors with terminal flower per 10 receptors	No. of flower primordia		Position indicating number of the 1st flower primordium	Date of start of short day treatment
					Total	Average per receptor		
I	1	78.6+(102.9)	5/43	0	10	0.2±0.11	2.4±0.22	June 14
	2	77.4+(86.6)	9/39	0	20	0.5±0.16	2.9±0.20	
	3	74.0+(90.2)	34/37	0.8	238	6.4±0.69	3.7±0.17	
II	1	(103.2)	34/34	2.9	293	8.7±0.29	1.7±0.10	June 14
	2	(84.7)	38/38	6.6	235	8.8±0.33	1.7±0.11	
	3	(91.5)	30/30	9.7	306	10.5±0.38	1.8±0.10	
III	1	(99.5)	34/34	0.9	254	7.5±0.79	2.5±0.10	June 15
	2	(86.5)	39/39	7.2	340	8.7±0.21	2.5±0.09	
	3	(94.9)	37/37	9.3	380	10.0±0.23	2.9±0.09	
IV	1	(100.6)	27/27	1.1	191	7.1±0.46	4.0±0.13	June 16
	2	(85.1)	25/25	3.6	232	8.6±0.28	3.6±0.16	
	3	(95.9)	26/26	9.3	234	9.0±0.33	3.9±0.13	

in less sensitive plants, and an increase of the position indicating number was the result.

Experiment 2. The results of another similar experiment, started on May 19, 1955, is shown in Table 2. The plants used in this experiment were very sensitive and many terminal flowers were produced. The reactivity of the receptor buds showed no change during the treatment. The position indicating number in the experimental group corresponds approximately to that of the third group, indicating that the stimulus in the experimental plants reached to the receptor bud about one day later than in the second group. Comparing the flowering response of the experimental group with that of the control group, a distinct difference can be seen. In the number of flowering receptors, in the number of receptors with terminal flower and in the average number of flower per receptor, the control groups markedly exceed the experimental group, in which the stimulus had to travel a stretch of the stem of ca. 7.6 cm. The results obtained are quite similar to those of Experiment 1.

Discussion

The flowering response of many short day plants, when a branch or a leaf is subjected to short day, is remarkably weakened by the presence of branches or leaves exposed to non-inductive light condition. In soy bean short day treatment given to one branch can cause flower initiation on another branch of the same

plant exposed to non-inductive light period, only when the latter is deprived of its leaves (1). The short day stimulus received by a donor branch of *Xanthium* can be more readily transmitted to a leafless receptor branch than to a receptor with leaves on long day (4). Such behavior was observed in many plants. It may be ascribed to various circumstances. In the first place the non-inductive leaves per se may counteract flower initiation. In *Perilla nankinensis* flowering occurs when the basal half of the leaf alone is exposed to short photoperiod. When the apical half of the leaf is exposed to short photoperiod the plant does not flower if the basal half is exposed to long day, but does if it is continuously maintained in darkness (2). In the second place the phenomenon may be ascribed to the generation of a solute stream from the non-inductive leaves opposed to the solute coming from the induced leaves. This explanation is very strongly supported by observations in *Kalanchoe Blossfeldiana* (5). The inhibitory effect is exerted exclusively by leaves located between the source of stimulus and the receiving bud, and the leaves on the same orthostichy with the donor leaf have a more pronounced effect than other leaves.

In *Kalanchoe* not only the non-inductive leaves but also the leaves kept in continuous darkness exert an inhibitory effect (10). Such leaves appear to act as sidetracks which intercept the solute stream carrying the floral stimulus, as Lang pointed out (7). This explanation seems very plausible, since in the present research the stimulus was found to become to some extent dissipated in normal transmission along the stem.

Summary

1) In two-branched plants flower initiation of the receptor bud on one branch induced by dark treatment given to the donor leaf on the other branch was compared with that of the axillary bud of the donor leaf.

2) The response was markedly reduced, when the donor and the receptor were separated by a stretch of stem, indicating that the stimulus was dissipated in the stem during transmission.

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Developmental Mechanics of Fucaceous Algae III. Differential Permeability in *Fucus* Eggs

by Singo NAKAZAWA*

中沢信午：フークス科植物の発生力学 III. *Fucus* の卵における差次透過性

Received August 30, 1956

Embryo development of *Fucus* was observed by Thuret et Bornet¹⁵⁾, Oltmanns¹³⁾, Nienburg¹¹⁾, and Inoh¹⁾. Its first stage, the polarity determination, has been studied by many experimental investigators with conclusions that the polarity can be determined by unilateral illumination¹⁹⁾, polarized light²⁾, temperature gradient⁴⁾, direct current⁵⁾, pH gradient¹⁸⁾, centrifuging¹⁷⁾, gradient of some diffusive substance¹²⁾, transformation of the egg shape²⁰⁾, and in some cases by the position of neighbouring eggs¹⁶⁾. This variety for the same determination reminds us of those various methods for artificial parthenogenesis, implying that there must be some fundamental mechanism to which those different cases are attributed. Such a mechanism is still unknown. However, the writer's preceding experiments on *Coccophora* and *Sargassum*, allied fucoids, reveal that a permeability gradient appears in accordance with the morphological polarity determination making various substances more permeable through the basal pole than through other part of the egg. This phenomenon suggests that the polarity determination in those algae may be unified to that of an agent, because the determination is valid in so far as it may affect the establishment of the permeability gradient. The present investigation was designed to verify the existence of a gradient of permeability along the morphological polarity axis.

At the end of May, 1956, the present writer made a visit to the Institute of Algological Research in Muroran, Hokkaido, and the present experiments were carried out there on eggs of *Fucus evanescens* collected at a nearby reef. Receptacles were cut off, washed, and then kept in glass vessels containing filtered sea-water. After a while, the eggs successively became detached and sank down to the bottom of the vessel. These eggs being hermaphrodite, had been previously fertilized in conceptacle. Taken up with pipette, the eggs were experimented at various stages of their development. Experiments were made in three ways: vital staining, rupture in distilled water, and cytolysis in toxic sea-water. For vital staining, nine dyes were separately dissolved at first in distilled water to a proportion of 0.1 per cent, then one or two drops of each stock solution were diluted into 10 cc of filtered sea-water. The material was put into these staining media on a hollow glass, and

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the staining pattern was observed after 30 minutes or so. Toxic sea-water was prepared by adding a drop of nicotine sulphate to 30 cc of sea-water. The same method was applied in testing cytolysis as in the vital staining.

1. Results of the vital staining experiment with brilliant green, Congo red, erythrosin, Janus green, methylene blue, neutral red, Nile blue, safranin, and toluidin blue are presented in Table 1. The staining begins on over all the surface uniformly before the morphological polarity is determined (Fig. 1a, b), while it begins selectively at the tip of the rhizoid protuberance as soon as the morphological polarity does appear (Fig. 1c). The staining spreads in time towards the apex till the whole stains uniformly. This phenomenon, the differential vital staining, was observed on seven out of nine dyes used. The fact seems to indicate that the morphological polarity is accompanied by a permeability gradient. This relationship was confirmed on some abnormal eggs. That is, in biaxial eggs, forming two rhizoids, vital staining appeared in each protuberance (Fig. 1d). This is in accordance with those observed in *Coccophora* and *Sargassum*^{8, 10}, implying that the differential staining, since it spreads in time till the egg is uniformly coloured, is attributed not to a partial decolorization of the uniformly invaded dye but to the differential permeability.

2. Cytolysis occurs when the egg is immersed in nicotine sulphate sea-water. The surface of the egg is blackened and destroyed in one or two minutes, and the intracellular material extrudes out of the egg. This destruction occurs uniformly on over all the surface before the morphological polarity does appear (Fig. 1e-g), while it occurs selectively in the basal pole with determination of the morphological polarity. This phenomenon was also confirmed in biaxial eggs (Fig. 1g-h). Observations correspond with those on *Coccophora* eggs.

Table 1. Vital staining of *Fucus* eggs.

Dyes	1-cell stage	2-cell stage			
		Before polarity determination		After polarity determination	
		The one cell	The other cell	Apical cell	Basal cell
Brilliant green	++	++	++	—	++
Congo red	—	—	—	—	±
Erythrosin	—	—	—	—	—
Janus green	±	±	±	—	+
Methylene blue	—	—	—	—	—
Neutral red	+	+	+	—	++
Nile blue	++	++	++	—	±
Safranin	+	+	+	—	++
Toluidin blue	++	++	++	—	++
Control	—	—	—	—	—

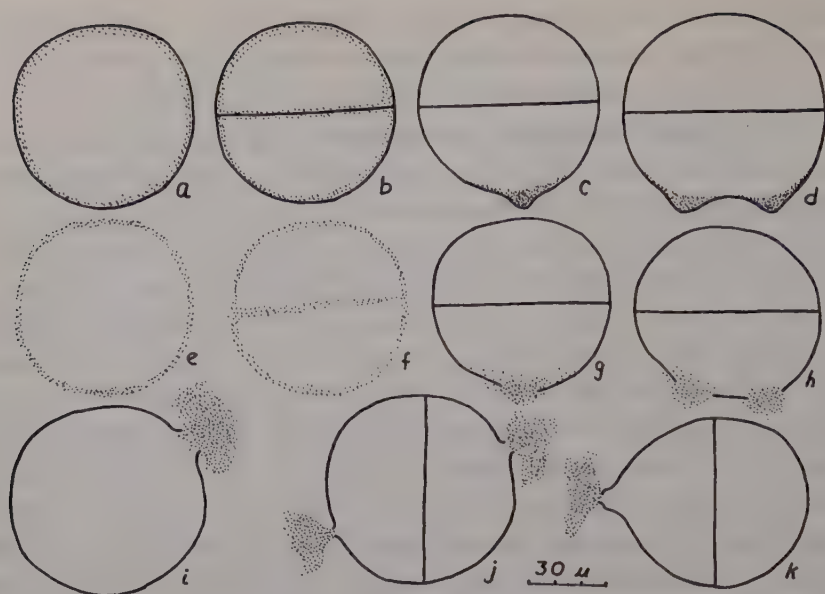


Fig. 1. Eggs of *Fucus evanescens*. a-d, vital staining (dotted) with brilliant green; e-h, cytolysis (dotted) with nicotine sulphate; i-k, rupture in distilled water, plasm extruded through the breakage is dotted. a, e, i, before cleavage; b, f, j, two-cell stage before morphological polarity appears; c, g, k, two-cell stage after morphological polarity was determined; d, h, biaxial eggs with two rhizoid protuberances.

3. When eggs at various stages are immersed in distilled water, they swell in two minutes or so, the membrane ruptures by turgor pressure, and the protoplasm extrudes out of the cell through the breakage. Before the first cleavage, the rupture usually occurs at one point (Fig. 1i). It is uncertain whether this point is definite or indefinite, as the egg is of spherical form. At the two-cell stage, the rupture sometimes occurs in each cell before the morphological polarity does appear (Fig. 1j). However, after the egg is more or less transformed into an ovate form, the rupture breaks out almost invariable on the pointed side, that is, in the basal pole (Fig. 1k). As the development proceeds further, rupture does not take place. This change indicates that cellulose has been accumulated to a great extent in the cell-wall with the progressive development resisting the rupture. A similar instance is reported in *Hormosira*³⁾, an allied fucoid.

The above experiments indicate that while the permeability in the beginning is uniform over all the egg surface, it increases eccentrically with the morphological polarity determination on the pointed side where the rhizoid protuberance is to be formed. It is reported that generally the permeability for various dyes is highest in the part where the growth activity is at the highest degree in various marine algae¹⁴⁾. Considering these reports, it is probable that in *Fucus* eggs also the permeability is highest in the basal pole. The polar rupture of the egg membrane in distilled water also implies the differential water permeability is highest in the

basal cell. Thus in *Fucus* eggs as well as in *Coccophora* and *Sargassum* the morphological polarity appears accompanied by a permeability gradient.

Summary

As a result of some experiments on eggs of *Fucus evanescens*, the following was revealed.

(1) Vital staining with various dyes and cytolytic pattern with nicotine sulphate appear uniformly over all the egg surface in the beginning of the development. But as soon as the morphological polarity is determined, these begin to appear partially in the basal pole, then spread towards the apex.

(2) When the egg is immersed in distilled water, it swells and finally ruptures. The rupture occurs at one point before cleavage and in each cell at two-cell stage before the morphological polarity determination, while merely in the basal cell after the determination.

(3) The facts above indicate the presence of a permeability gradient along the morphological polarity axis, highest in the basal, i.e. the rhizoid pole.

The writer expresses his thanks to Dr. Y. Yamada, Dr. Y. Nakamura, Mr. K. Kasahara, and Miss Mutsumi Suzuki of the Institute of Algological Research, Muroran, Hokkaido, for their kind cooperation. The writer is also grateful to Dr. S. Inoh of the Okayama University for his valuable suggestions.

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Über den Einfluss von Auxin auf die Stoffpermeabilität des Protoplasmas III.

Die Wirkung von 2,4-Dinitrophenol auf die Harnstoffpermeabilität der Avena-Koleoptile

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増田芳雄*: 原形質の溶質透過性に対するオーキシンの影響について 第3報

Eingegangen am 27. September 1956

In neuerer Zeit haben manche Forscher den Mechanismus der Auxin-Wirkung untersucht. Die Beziehung zwischen der Zellstreckung und dem Metabolismus, besonders der Respiration, ist erforscht worden (Bonner, 1933, 1936, 1948, 1949a u. b). Aber es gibt nur noch wenige protoplasmatologische Arbeiten über die Auxin-Wirkung. Zuerst hat der Verfasser gezeigt, dass das Auxin die Permeabilität für Harnstoff, Glyzerin, u. s. w. beeinflusst (Masuda, 1953), und dass die Permeabilitätserhöhung in den lebendig wachsenden Zellen zu bemerken ist (Masuda, 1955 a).

Andererseits hat Bonner (1949a u. b) den Einfluss des 2,4-Dinitrophenols (DNP) auf die Respiration und die Streckung der Avena-Koleoptile genau untersucht und er hat auch bewiesen, dass 1-5 mg/l DNP die O₂-Aufnahme erhöht, 10 mg/l sie anhält und alle beide die Streckung niederschlagen. Daraus schloss er also, dass die Streckung zu der Phosphorylation in enger Beziehung steht. Der Zusammenhang der Respiration und der Änderung des Kolloidzustandes von Protoplasma ist jedoch unverständlich geblieben.

Hier wird die Wirkung von DNP auf die Harnstoffpermeabilität dargestellt werden, und dann wird sie mit der des Auxins verglichen werden.

Material und Methode

Als Untersuchungsobjekt wurden die Innenepidermiszellen des wachsenden Teiles der etiolierten Koleoptilen von *Avena sativa* gewählt. Das verwendete Material und die versuchte Methode sind gleich wie die frühere Untersuchungen (Masuda, 1955a u. b). Das Material wurde im feuchten Sägemehle in der Dunkelheit bei 25° C wachsen lassen. Die bis etwa 3 cm lang gewachsenen Koleoptilen (etwa nach 4 Tage) wurden zur Untersuchung benutzt. Ein 4 mm langes Zylinderstück, das von der Spitze der etiolierten, etwa 30 mm langen Koleoptile 4-5 mm entfernt war, wurde abgeschnitten. Es wurde nach der etwa 3 Stunden langen Wässerung in die

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Versuchslösung überführt. Dann wurde von diesen Koleoptilenzylindern der Schnitt, welcher die Leitbündel nicht enthielt, herausgeschnitten und ins Diosmotikum gebracht.

Für die Permeabilitätsbestimmung wurde die P' nach der Deplasmolysezeit-Methode von Hofmeister (Pd', 1948) verwendet, Pd' von Hofmeister ist die Permeationskonstante P' , welche aus der Deplasmolysezeit gerechnet wird. Sie wird im folgenden nur als Formel $\frac{120 (C-O)}{T (C+O)}$ angegeben, da $P' = \frac{M}{C-c}$, $M = \frac{60 (C-O)}{T}$, $c = \frac{C-O}{2}$, wo C=Konzentration des Plasmolytikums, c=Konzentration der eingebrungenen Substanz im Zellsaft, M=die pro Stunde aufgenommene Menge der permeierenden Substanz in Mol., O=osmotischer Wert des Objektes, T=Deplasmolysezeit. Der osmotische Wert des Objektes wurde in folgender Weise gemessen: Die gleichartigen Epidermisstücke wurden in die Saccharoselösungen der verschiedenen Konzentrationen gebracht und dadurch wurde der O-Wert in der Konzentration bestimmt, in der die 50 %igen Zellenzahlen plasmolysiert waren. Dieser Wert wurde auch dadurch bestätigt, dass der in der 1 M Saccharoselösung gezeigte Plasmolysegrad in den O-Wert umgerechnet wurde. Die Deplasmolysezeit ist diejenige Zeit, in der 2/3 bis 3/4 der Querwände mit dem Protoplaste in Berührung sind (Hofmeister, 1948).

Die Konzentration der Indolessigsäure (im folgenden IES abgekürzt), die in diesen Versuchen verwendet wurde, war 10 mg/l, welche die Zellstreckung sowie die Permeabilität fördert (Masuda 1953, 1955a u. b). DNP-Konzentrationen von 3 und 10 mg/l wurden nach dem oben erwähnten Grunde verwendet.

Der pH-Wert der Versuchslösung, welcher zur Wirkung des DNP optimus ist, wurde mit 0.01 M KH_2PO_4 in 4.5 reguliert und die Lösung enthielt auch 2 %ige Saccharose (Bonner, 1949a; Masuda, 1955a). Als Diosmotikum wurde die 0.7 M Harnstofflösung gewählt. IES, DNP und Harnstoff waren die reinsten Präparate von Firma Merck, Katayama bzw. Muto.

V Versuchsergebnisse

Der Plasmolyse-Deplasmolyseverlauf der Zelle, die nach 3 Stunden Wässerung in die Harnstofflösung gebracht wurde, wird gewöhnlich in Abb. 1 gezeigt.

Erst nach einigen Minuten (T_a) löste sich der Protoplast von beiden Querwände ab, und fortlaufend wird die Protoplastenlänge allmählich kürzer infolge des Ausgangs des Zellsaftwassers. Dann wird die Protoplastenlänge minimal (T_m), und danach wird der Protoplast immer länger infolge des Eindringens des gelösten Stoffes. Die ganze Zeit, die zu diesem Verlaufe nötig ist, ist die Deplasmolysezeit (T). Diese Deplasmolysezeit wird einerseits das Merkmal der Permeabilität für den gelösten Stoff und andererseits werden auch T_a und T_m eine Art Ausdruck der Wasserpermeabilität. Während dieses Verlaufes verwandelt sich auch die Plasmolyseform von der konkaven in die konvexe.

Ein Beispiel der Pd'-Messungsergebnisse wird im Folgenden gegeben: 23. 2. 1956. Ein Schnitt nach Wässerung von 2 Stunden mit Phosphatpufferlösung in $C=0.7$ M Harnstoff eingelegt; 1^h 44'. Die Protoplasten plasmolysierten nach 5 min. (Ta), rundeten bis nach 9 min. (Tm) und deplasmolysierten.

$C=0.7$ M Harnstoff.

$O=0.38$ M Saccharose.

Deplasmolysezeit: $T=24$ min.

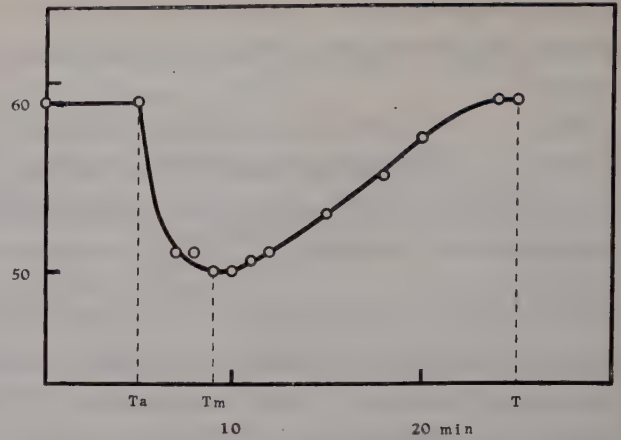


Abb. 1. Der Plasmolyse-Deplasmolyseverlauf. Der Schnitt wurde nach 3 Stunden Wässerung in die 0.7 M Harnstofflösung gebracht. pH 4.5, 25°C. Abszisse: Zeit in Minuten. Ordinate: Protoplastenlänge in Mikrometerskalenteilen.

$$Pd' = \frac{120(C-O)}{T(C+O)} = \frac{120(0.70-0.38)}{24(0.70+0.38)} = \frac{38.40}{25.92} = 1.48$$

Abb. 2. zeigt die Pd'-Werte aus allen Versuchen der Hauptreihe.

Es ist dabei bemerkenswert, dass IES mit den Wirkungszeiten die Permeabilität für Harnstoff beträchtlich erhöht und umgekehrt 10 mg/l DNP sie hemmt. Nach der anfänglichen Erhöhung wird sie aber durch 3 mg/l DNP gehemmt. Wenn auch DNP zur IES hinzugefügt wird, zeigt die Permeabilität fast keinen Unterschied. Man muss also beachten, dass das Mitvorhandensein von DNP in IES-Lösung die eigentliche IES-Wirkung völlig anhält.

Da das durch 10 mg/l DNP verursachte Permeabilitätshemmnis auffallend ist, wird sein Einfluss auf die Plasmolyseverläufe klar gezeigt.

Die Deplasmolysezeiten werden um so länger, je länger die Vorbehandlung von DNP dauert, Ta und Tm auch in gleicher Weise. In diesem Falle wird

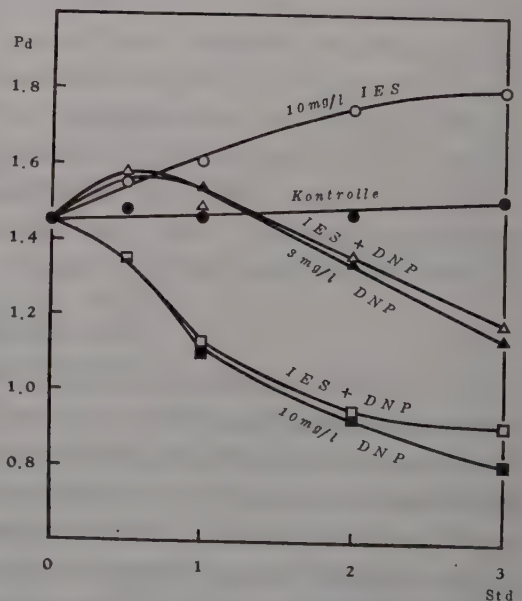


Abb. 2. zeigt die Pd'-Werte aus allen Versuchen der Hauptreihe.

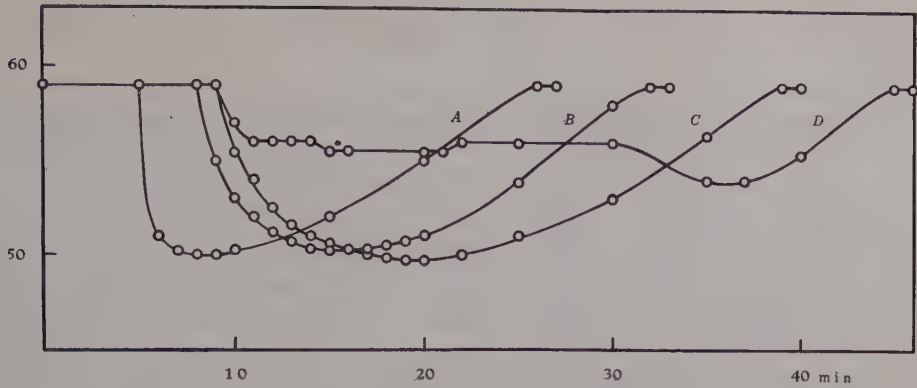


Abb. 3. Die Plasmolyse-Deplasmolyseverläufe der Zellen, die 10 mg/l DNP verschiedenen Zeiten lang gegeben wurde. Abszisse: Zeit in Minuten. Ordinate: Protoplastenlänge in Mikrometerskalenteilen. Vorbehandlungszeiten; A: 30 min, B: 60 min, C: 120 min, D: 180 min.

Tabelle 1. Ta- und Tm-Werte. Wirkungszeiten, Ta und Tm in Minuten.

Behandlungen	Wirkungszeiten			
	30	60	120	180
Kontrolle	Ta = 4—5 Tm = 9—10	4—5 9—10	4—5 9—10	4—5 9—10
IES	4—5 9—10	3—4 7—8	3—4 6—7	2—3 6—7
3 mg/l DNP	4—5 9—10	3—4 9—10	3—4 9—10	4—5 11—12
— + IES	3—4 7—8	3—4 8—9	3—4 9—10	4—5 11—12
10 mg/l DNP	4—5 11—12	8—9 16—17	9—10 19—20	9—10 —
— + IES	4—5 11—12	8—9 15—16	9—10 17—18	9—10 20—21

also die Wasserpermeabilität sowie die Stoffpermeabilität durch DNP gehemmt.

Die Tabelle 1 zeigt Ta und Tm aus allen Versuchen. Diese Ergebnisse zeigen, dass die Harnstoffpermeabilität mit der Wasserpermeabilität allgemeinparallel ist, mit anderen Worten, die Wasserpermeabilität auch die Wirkungen dieser Wirkstoffe beeinflusst wird.

Im Falle von D in Abb. 3 wurden die Plasmaoberflächenzustände durch die langzeitige Wirkung von DNP beträchtlich verändert und die Plasmolyseform war unregelmässig.

Eine andere auffällige Erscheinung in diesen Versuchen ist die Änderung der Plasmolyseform. Das ist dadurch klar, dass der Kolloidzustand des Protoplasmas durch die Wirkstoffe beeinflusst wird. Tabelle 2 zeigt die Plasmolyseformen und Plasmolysezeiten, die nötig ist, um die konvexe Plasmolyse zu erreichen.

Tabelle 2. Plasmolyseformen und Plasmolysezeiten. Wirkungs- und Plasmolysezeiten in Minuten.

Behandlungen	Wirkungszeiten	Plasmolyseformen	Plasmolysezeiten
Kontrolle	30	konk. → konv.	9—10
	60	"	"
	120	"	"
	180	"	"
IES	30	krampf. → konv.	11—12
	60	"	11—12
	120	"	13—14
	180	"	13—14
3 mg/1 DNP	30	konk. → konv.	7—8
	60	fast konv.	fast 0
	120	konv.	0
	180	"	"
— + IES	30	konk. → konv.	7—8
	60	fast konv.	fast 0
	120	konv.	0
	180	"	"
10 mg/1 DNP	30	konv.	0
	60	"	"
	120	"	"
	180	—	—
— + IES	30	fast konv.	0
	60	konv.	"
	120	"	"
	180	"	"

Im Falle der Kontrolle verändert sich die Plasmolyseform von konkav zu konvex. Bei der Zufügung von IES erscheint anfangs die Krampfform und gewöhnlich von der konkaven in die konvexe Form. Wenn das DNP von 3 oder 10 mg/1 mit oder ohne IES gegeben wird, die Plasmolyseform von Anfang an konvex. Diese Erscheinungen zeigen, dass IES die Adhäsion zwischen dem Protoplasma und der Zellwand oder der Viskosität des Plasmas erhöht und dass DNP sie erniedrigt. Die Untersuchungen über die Plasmolyseform oder -zeit sind in Bezug auf die physikalisch-chemischen Eigenschaften des Protoplasmas, besonders Viskosität, langjährig gemacht worden (Heilbrunn, 1928; Weber, 1925, 1929; Cholodny u. Sankewitsch, 1934; Schaefer, 1955). Namentlich hat Schaefer (1955) nach der Quantitativierung der Plasmolyseformmethode die Plasmaviskosität untersucht und er hat gezeigt, dass die Plasmolysezeit eher die Adhäsion als die Viskosität bezeugt. Jedenfalls ist es gewiss, dass die Kolloidzustände des Protoplasmas durch IES oder DNP beträchtlich beeinflusst werden.

Aber wenn 10 mg/1 DNP 3 Stunden lang gegeben wird, nimmt die Plasmolyseform einen besonderen Charakter an. In diesem Falle kann man sich denken, dass 10 mg/1 DNP die Oberflächenspannung des Protoplasmas erhöht oder die Gelation der Plasmaoberfläche erregen lässt.

Besprechung der Ergebnisse

Aus den oben erwähnten Ergebnissen stellt sich heraus, dass IES die Wasser- und Stoffpermeabilität und die Viskosität oder Adhäsion des Protoplasmas erhöht, und dagegen DNP den Konzentrationen gemäss auf die Permeabilität anders beeinflusst, aber die Viskosität oder Adhäsion einheitlich erniedrigt. Dass die Permeabilität für gelöste Stoffe durch IES beeinflusst wird und dabei diese Wirkung des Auxins durch die Hinzufügung einer gewissen Menge Zucker verstärkt wird (Masuda, 1953, 1955 a; Busse u. Kandler, 1956), ist darauf zurückzuführen, dass die Änderung der Permeabilität an dem Zellmetabolismus beteiligt ist.

Der Zusammenhang zwischen der Zellstreckung und der Respiration ist wohl bekannt. Nach Bonner (1949a u. b, 1952) ist es klar gemacht, dass 1-5 mg/l DNP die O₂-Aufnahme der Avena-Koleoptile zunimmt, aber 10 mg/l DNP sie fast gänzlich niederhält und alle beide ihre Streckung anhalten. Er zeigt auch, dass die O₂-Aufnahme durch IES erhöht wird, 10mg/l DNP aber diesen IES-Effekt hemmt.

Aus diesen Verhältnissen schloss er, dass der Einfluss der IES auf die Respiration durch den Teil des Systems hindurch ausgeführt wird, welcher durch DNP entkuppelt wird. Aus diesen Tatsachen ist es zweifelhaft, ob es einen direkten Zusammenhang zwischen der Respiration und der Streckung gibt. Zum Beispiel zeigen Busse und Kandler (1956), dass die durch IES entstandene Respirationserhöhung mehr verspätet als die Streckungszunahme der Koleoptile kommt. Sie haben also gezeigt, dass die letzter vielleicht die Ursache der ersteren ist. Aber sie haben noch nicht die Untersuchungen über die Wirkung von IES auf die Plasmazustände angestellt.

Es ist bereits bekannt, dass die IES-Wirkung auf die Stoffpermeabilität durch die Lipoidlöslichkeit oder Molekülgrösse permeierender Stoffe reguliert wird (Masuda, 1955b), und man kann sich also vermuten, dass IES die physikalisch-chemischen Eigenschaften des Plasmas verändert und diese Änderung der Plasmazustände die Permeabilitätsänderung veranlasst. Es ist ein wesentlicher Punkt, dass IES sowie DNP den Kolloidzustand des Protoplasmas beträchtlich ändert. Die Erscheinung, dass DNP die Viskosität des Plasmas erniedrigt, wurde schon nach Kamiya et al. (1954) gezeigt. Weiter ist es nach Masuda und Takada (1956) bewiesen worden, dass die Adhäsion zwischen dem Plasma und der Zellwand durch Auxin erhöht und durch Antiauxin oder DNP erniedrigt wird. Jedenfalls ist es selbstverständlich, dass die physikalisch-chemischen Eigenschaften des Plasmas mit dem Zellmetabolismus, folglich mit der Streckung, in enger Beziehung zueinander stehen.

Hier sei es dem Verfasser gestattet, seinem verehrten Lehrer, Herrn Prof. Dr. Joji Ashida, Universität Kyoto, für seine Anregung und ständige Anleitung den besten Dank auszusprechen. Ebenso dankt er Herrn Prof. Dr. Hideo Takada, Osaka Stadt-Universität, für seine wertvolle Unterstützung bei der Arbeit.

Zusammenfassung

1. 2,4-Dinitrophenol, das der unkuppelnde Stoff der oxidativen Phosphorylation ist, beeinflusst die Harnstoffpermeabilität der Innenepidermiszellen der etiolierten Avena-Koleoptile.

2. 3 mg/l DNP erhöht anfangs die Permeabilität und dann erniedrigt sie mit den Wirkungszeiten. 10 mg/l DNP hemmt sie von Anfang an gänzlich. Jedoch erniedrigen beide die Viskosität oder Adhäsion des Protoplasmas.

3. DNP hält die Wirkung von IES an, welche die Harnstoffpermeabilität sowie Viskosität oder Adhäsion erhöht.

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伊豆片瀬, 谷津, 湯が島温泉のケイ藻

小 林 艶 子*

Tsuyako KOBAYASHI*: Diatom Vegetation of Izu Katase,
Yatsu and Yugashima Spas

1956 年 9 月 15 日受付

伊豆半島には非常に沢山の温泉があり、これらの微生物学的の研究は古くは三好学博士及び H. Molisch 博士、近年には江本義教、広瀬弘幸両博士、小林弘氏等により行われ、非常に良く研究された地域であるが、ケイ藻類に関しては江本、広瀬両博士が *Melosira varians* Ag. が湯が島西平温泉第 4 号源泉 (40°C, pH 5.2) に *Mastigocladus laminosus*, *Calothrix parietina* の藻被中に混在して多産すること、*Melosira* sp. が修善寺温泉独鈷の湯支管 (34.5°C, pH 5.2) に産することを記しているのみで他は全く不明状態である。本大学の福島博助教授は昭和 30 年 1 月 6 日より 8 日迄伊豆熱川、片瀬、峰、湯が野、小鍋、湯が島等の温泉を調査して 54 本の管瓶入りの材料を著者に提供して下さったので研究を行ったが、この中珪藻を普通に見出したのは片瀬温泉、谷津温泉の一部及び湯が島西平温泉であった。

研究材料を提供して下さい、御指導及び校閲をして下さった福島博先生に厚く感謝致します。

I. ケイ藻を普通に見出した源泉

1. 片瀬温泉湯の沢噴泉 (St. I)

湯の沢にある源泉でパイプで引いて温室に利用されているがこの漏水に少しラン藻が発生し、これにケイ藻が少し混じっていた。この場所の水温 43°C, pH 7.6, 塩素イオン 0.988g/l で、ケイ藻群落は *Pinnularia Kneuckeri*—*Navicula cryptocephaloides* 群落であった。この源泉の水質は未だ分析されていないようであるが、筆者の調査では塩素イオンが相当含まれているためこの源泉で見出した

ケイ藻 14 種 (変種、品種を含む。以下同じ) の中 *Gomphonema parvulum* var. *micropus*, *Navicula cryptocephala*, *N. c.* var. *veneta*, *N. cryptocephaloides*, *Nitzschia frustulum* var. *perpusilla* の 5 種が塩分を好む種であった。尚本源泉の植物学的研究は今迄に行われていないようである。

2. 谷津温泉石田屋旅館源泉 (St. II)

谷津温泉は弱食塩泉に属し、厚生省東京衛生試験所分析の河津村字鷲頭 181 番地源泉の塩類表は次のようになっている。

谷津温泉塩類表: KCl 0.467, NaCl 0.9259, Na₂SO₄ 0.1488, CaSO₄ 0.1782, Ca(HCO₃)₂ 0.0233, Mg(HCO₃)₂ 0.0217, Al₂(SO₄)₃ 0.0008, H₃BO₃ 0.006, H₂SiO₃ 0.1969, CO₂ 0.001。

谷津温泉では 43 号泉と本石田屋旅館源泉を調査したが、後者の引湯管の漏水が小さい水溜をなしている底のケイ藻群落は *Pinnularia Kneuckeri* 群落であった。この場所の環境要因は水温 12.4°C, pH 7.8, RpH 8.0, 塩素イオン 0.529 g/l で汽水域に属する程度に塩素イオンを含有しているが、この場所で見出された 13 種の中 *Nitzschia obtusa* var. *scalpelliformis* f. *nipponica* のみが塩分を好む種であった。

3. 湯が島西平温泉

湯が島温泉は世古の滝、木立、西平の 3 温泉に分れておりいずれも調査したが、ケイ藻の普通に見られるのは西平温泉のみであった。西平温泉は狩野川の右岸に湧出するので源泉は数箇所あり、筆者の調査したのは共同湯源泉と川床中の岩石の裂目より湧出するものの 2 箇所及び溪山荘源泉であ

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ったが、共同湯源泉を除いた他にはケイ藻が夥しく見られた。この温泉の水質分析はまだ行われていないようであるが、今回の調査では塩素イオンの含有量は非常に少かった。

i) 河床中の源泉 (St. III, IV)

岩石の裂目より相当量湧出しているが利用されていない。水温 37.4°C 及び 36.8°C, pH 7.2, 塩素イオン 0.071 g/l で2つの材料とも *Achnanthes exigua* 群落で 24 種のケイ藻を見出した。

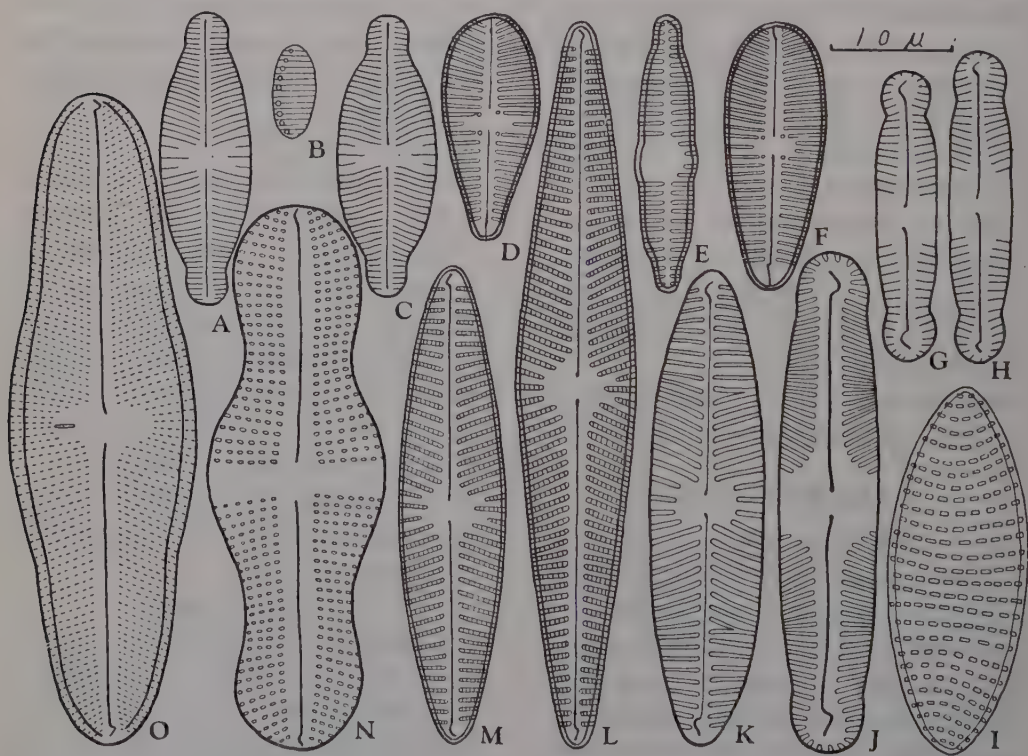
ii) 河床中の源泉 (St. V, VI)

i) と同様に岩石の裂目より湧出するものであるが湧出量は非常に少かった。岩石に附着する糸状のケイ藻群落と水溜の底の群落を調査したが、前者は *Melosira varians* 群落、後者は *Cymbella ventricosa* 群落でいずれもケイ藻は夥しく種類も豊富で 66 種見出された。この場所の水温は 24.0

°C, pH 7.5, RpH 7.3, 塩素イオン 0.053 g/l であった。

iii) 溪山荘引湯管漏水 (St. VII, VIII)

溪山荘への引湯管の漏水にみられた暗青色のラン藻の藻被及び淡緑褐色のケイ藻群落を調査したところ、前者は *Achnanthes exigua* 群落、後者は *Achnanthes exigua*—*Pinnularia Kneuckeri* 群落でこの源泉では 37 種見出しケイ藻は夥しく産した。尚この場所の水温は 40.0°C 及び 30.0°C, pH 7.3, RpH 7.3, 塩素イオン 0.030 g/l であった。河床及びその附近に湧出する温泉のケイ藻群落の複雑なことは福島(1955)がすでに指摘しているが、この西平温泉のケイ藻群落も非常に複雑で真流水性のものに *Achnanthes lanceolata*, *Navicula cryptocephala* var. *veneta*, *Nitzschia linearis*, 好洗性のものに *Cymbella ventricosa*, *Gomphonema*



A, C: *Navicula decussis* B: *Nitzschia frustulum* var. *perpusilla*
D, F: *Gomphonema tetrastigmata* E: *Ceratoneis arcus* var. *vaucheriae* f. *kamtschatica* G, H: *Pinnularia kneuckeri*
I: *Achnanthes brevipes* J: *Pinnularia interrupta* K: *Navicula graciloides* L, M: *Navicula oppugnata* N: *Achnanthes inflata*
O: *Navicula mutica* f. *undulata*

parvulum, *G. p.* var. *micropus*, *N. menisculus*, *N. viridula*, *Nitzschia dissipata* があり, 真止水性のものに *Neidium affine*, *N. iridis* f. *vernalis*, *Surirella biseriata* var. *bifrons*, *S. elegans*, *S. robusta*, 好止水性のものに *Cyclotella comta*, *Gyrosigma Kützingii* があった。本温泉には塩素イオンは余り含有されていないが, 塩分を好むものに *Achnanthes brevipes*, *A. b.* var. *intermedia*, *Gyrosigma Spencerii*, *Navicula cryptocephala*, *N. c.* var. *veneta*, *N. cryptocephaloides*, *Nitzschia frustulum* var. *perpusilla*, *N. obtusa* var. *scalpelliformis* f. *nipponica*, *Surirella ovalis* があった。

II. 主要ケイ藻について

1. *Achnanthes exigua* Grunow

小流水によく見出される種でしばしば純群落を形成するが *N. Foged* は流水に対して不定性としている。塩分に対しても不定性である (Boye-Petersen 1943, Foged 1948, 1954)。今回西平温泉 i 及び iii ($Cl^- = 0.071, 0.030$ g/l, 水温 $37.4, 36.8, 40.0^\circ C$) の群落主要構成であった。日本では数箇所淡水域及び二十数箇所の温泉で記録されており, 最高水温は $47^\circ C$ である。

2. *Cymbell ventricosa* Kütz.

各種の水域に良く見出される種で特に流水域に多く *N. Foged* は好流水性としており塩分に対しては不定性 (Kolbe 1927, Boye-Petersen 1943, Foged 1948, 1954) とされており, 今回西平温泉 ii ($Cl^- = 0.053$, 水温 $24.0^\circ C$) の群落主要構成種として見出されたもので, 既に本邦に於いても温泉及びその他の水域で夫々十余箇所で見出されている。

3. *Melosira varians* C. A. Ag.

種々な水域に普通に見られるケイ藻であるが, 特に流水域には多いようで, しばしば糸状のおびただしい群落が見られ, 本邦に於いて約十箇所の温泉と百余箇所の淡水域で記録され, 西平温泉でも江本, 広瀬両氏が四号泉で見出している。

4. *Navicula cryptocephaloides* Hustedt

本種は中央及び西部ジャワ及びバリ島で採集されたものを Hustedt が新種として記載したもので形態的に *N. cryptocephala* Kütz. に類似しているが, 両端部以外の横条線がより弱い放射状を

なすことと, 横条線の間隔が大きい点で区別することが出来る。生育環境も *N. cryptocephala* によく似て塩分を含む水域に多いようで, 本邦に於いては未記録であったが, 筆者は塩原, 白浜両温泉でも見出した。日本の塩類泉にはかなり広く分布しているものと考えられる。

5. *Pinnularia Kneuckeri* Hustedt

本種はエジプトの Sinai 地方の材料について, Hustedt が 1949 年に新種として発表した種で同地方には広く分布し稀では無いようである。伊豆地方で見出した個体はケイ殻の形がやや異なるが一応本種としておく, 日本新種である。

注目すべき種について

1. *Achnanthes crenulata* Grunow

熱帯アジア及びオーストラリアに分布するケイ藻で本邦では最近小田原城跡で津村・岩橋両氏 (1955) 及び津村氏 (1956) によって見出され, 岩橋氏が屋久島及び甑島より見出したケイ藻を *Achnanthes repanda* として報告した種 (図をともなった日本語の記載文しかなく正式に発表された学名ではないが) は *Achnanthes crenulata* のシノニムであると津村・岩橋氏 (1955) は報じている。福島先生の未発表資料によると下甑島牛片の溪流, 兵庫県朝来郡伊由谷川及び円山川柳橋附近でも見出されているので本種は日本に可成り広く分布しているのではないかと考えられる。

Hustedt (1938) は本種は pH 5.5 より 8.5 までに見出されるが, pH 7.7~8.1 のアルカリ水域に多く出現するとしており, 今回の地点の pH は 7.2, 7.3, 7.5 であった。

2. *Cymbella sumatrensis* Hustedt

Hustedt (1938) がスマトラで見出した種で現在迄はスマトラで知られているのみのようであるが, 福島 (1954) は尾瀬の猫又川, ムジナ沢, 川上川, 沼尻川で採集したが今回も西平温泉で見出したが, 本邦の流水域にはかなり広く分布しているのではなからうか。Hustedt は止水域, 流水域や湖沼の沿岸帯に見られ, 又本種のみられる水域の pH は 5.5~8.6 で多量に見られるのは 8~8.6 であるとしている。

3. *Nitzschia obtusa* (Kütz.) var. *scalpelliformis* f. *nipponica* Negoro

基準変種と異なる点は小型な点と構造の繊細な点

である。本種は日光湯本温泉、四万温泉、磯部鉱泉、埼玉県志木町附近、下賀茂温泉、海地獄、十萬地獄、阿蘇地獄温泉元湯附近で記録されており、本邦の温泉特に酸性泉及び塩類泉に広く分布しているようである。

ケイ藻目録

(種名の次のローマ数字は採集地点、その次の()内の数字は出現率を%で現わした数字)

1. *Achnanthes brevipes* Agardh IV. 日本温泉新産種.
2. — — var. *intermedia* (Kütz.) Cleve V, VI.
3. — *crenulata* Grun. IV, V, VI, VII. 日本温泉新産種.
4. — *exigua* Grun. I (4), II (9), III (99.5), IV (98.5), VI (0.5), VII (97), VIII (52).
5. — *inflata* Kütz. VI.
6. — *lanceolata* Bréb. IV, V, VI, VII.
7. *Amphora strigosa* Hust. I, II (20), V, VI, VII. 日本新産種.
8. *Caloneis bacillum* (Grun.) Meres. var. *lancettula* (Schulz) Hust. V.
9. *Ceratoneis arcus* Kütz. var. *vaucheriae* (Kütz.) Fukus. et Koba-Yas. IV, V (1), VII. 日本温泉新産種.
10. — — — f. *kamtchatica* (Boye-Pet.) Fukus. et Koba-Yas. IV, VI. 日本新産種.
11. *Cocconeis placentula* Ehr. V, VII, VIII.
12. — — var. *euglypta* (Ehr.) Cleve II, III, IV, IV, V, VI, VII.
13. — — var. *lineata* (Ehr.) Cleve III, IV, V, VII.
14. — — var. *Rouxii* (Brun & Hérib.) Cleve IV. 日本新産種.
15. *Cyclotella comta* (Ehr.) Kütz. VII.
16. *Cymatopleura solea* (Bréb.) W. Sm. V, VI (2).
17. *Cymbella affinis* Kütz. V.
18. — *sumatrensis* Hust. V (0.5), VI, VII. 日本温泉新産種.
19. — *tumida* (Bréb.) V. Heurck. III, V, VI, VII, VIII.
20. — — var. *borealis* Grun. IV.
21. — *turgida* (Greg.) Cleve VIII.
22. — *ventricosa* Kütz. V (10), VI (375), VII, VIII.
23. *Frustulia rhomboides* (Ehr.) De Toni var. *amphipleuroides* Grun. IV, VI, VIII.
24. — *vulgaris* Thw. VII.
25. *Gomphonema constrictum* Ehr. var. *capitata* (Ehr.) Cleve V. 日本温泉新産種.
26. — *longiceps* Ehr. var. *subclavata* Grun. I (4), VI. 日本温泉新産種.
27. — *parvulum* Kütz. V, VII.
28. — — var. *micropus* (Kütz.) Cleve I, III (0.5), VI (1). 日本温泉新産種.
29. — *tetrastigmata* Horik. et Okuno III, IV, V, VI (0.5), VII, VIII. 日本温泉新産種.
30. *Gyrosigma Kützingii* (Grun.) Cleve V.
31. — *spencerii* (W. Sm) Cleve VI.
32. *Hantzschia amphioxys* (Ehr.) Grun. I (8), II (2).
33. *Melosira varians* C. A. Ag. III, IV (0.5), V (63), VI (55), VII, VIII.
34. *Navicula bacillum* Ehr. I, VI (1.5).
35. — *cryptocephala* Kütz. I, VI (1.5).
36. — — var. *veneta* (Kütz.) Grun. I, V, VI (1.5).
37. — *cryptocephaloides* Hust. I (30), III, IV (10), VII, VIII (0.5). 日本新産種.
38. — *decussis* Oestrup V, VI (0.5), VII. 日本新産種.
39. — *exigua* (Greg.) O. Müller V.
40. — *graciloides* A. Mayer V. 日本新産種.
41. — *incognita* Krasske I. 日本新産種.
42. — *menisculus* Schum. VII.
43. — — var. *sinica* Skv. VII. 日本新産種.
44. — *mutica* Kütz. II.
45. — — f. *undulata* (Hilse) Grun. VII.
46. — *oppugnata* Hust. V, VI (2). 日本温泉新産種.
47. — *radiosa* Kütz. V (3.5), VI (5), VIII.
48. — *viridula* Kütz. VI. 日本新産種.
49. *Neidium affine* (Ehr.) Cleve VI.
50. — *dubium* (Ehr.) Cleve V, VI. 日本温泉新産種.
51. — *iridis* (Ehr.) Cleve f. *vernalis* Reich.

- VIII. 日本新産種.
52. *Nitzschia clausii* Hantz. V,
53. — *dissipata* (Kütz.) Grun. IV, V(3), VI (13), VII (1), VIII (0.5).
54. — *frustulum* (Kütz.) Grun. var. *perpusilla* (Rabenh.) Grun. I (2).
55. — *linearis* W. Sm. III, IV(0.5), VI(7.5), VII (2).
56. — *obtus*a W. Sm. var. *scalpelliformis* Grun. f. *nipponica* Negoro II, V (1.5), VI (1.5).
57. — *palea* (Kütz.) W. Sm. V (8.5), VI (6).
58. *Pinnularia borealis* Ehr. I. 日本温泉新産種.
59. — *interrupta* W. Sm. I.
60. — *Karelia* Cleve VI (0.5). 日本温泉新産種.
61. *Rhoicosphaenia curvata* (Kütz.) Grun. II, III, IV, VI, VII, VIII.
62. *Rhopalodia gibberula* (Ehr.) O. Müll. II, V (1), VII, VIII (0.5).
63. *Stephanodiscus astraea* (Ehr.) Grun. VI (0.5), VII. 日本温泉新産種.
64. *Surirella biseriata* Bréb. var. *bifrons* (Ehr.) Hust. V (1), VI. 日本温泉新産種.
65. — *elegans* Ehr. V.
66. — — f. *constricta* Mayer V, VI(0.5). 日本新産種.
67. — *ovalis* Bréb. VIII.
68. — *robusta* Ehr. V. 日本温泉新産種.
69. — — var. *splendida* van Heurck f. *punctata* Hust. VI. 日本温泉新産種.
70. *Synedra ulna* (Nitz.) Ehr. II, III, IV, V (4.5), VI (3), VIII (0.5).
71. — — var.? III, IV, V (1), VI (1), VII.
72. — — var. *oxyrhynchus* (Kütz.) van Heurck VI.
73. — — var. *Ramesi* (Hérib. et Perag.) Hust. VI, VII.

Summary

At eight among fifty stations of Atakawa, Katase, Yatsu, Mine, Yugano, Konabe and Yugashima spas in the Izu Peninsula of Shizuoka Pref., the writer found abundant diatoms. They amount to seventy-three taxons, and those data are as follows :

Place	Station	pH	Water Temp.	Air Temp.	Cl ⁻ mg/l	Diatom Community
Katase spa	I	7.6	43.0	7.8	988	<i>Pinnularia Kneuckeri</i> - <i>Navicula cryptocephaloides</i> Association
Yatsu spa	II	7.8	12.4	9.5	529	<i>Pinnularia Kneuckeri</i> Assoc.
Yugashima Nishihira spa	III	7.2	37.4	5.5	71	<i>Achnanthes exigua</i> Assoc.
ibid.	IV	—	36.8	—	—	<i>Achnanthes exigua</i> Assoc.
ibid.	V	7.5	24.0	—	53	<i>Melosira varians</i> Assoc.
ibid.	VI	7.5	24.0	—	53	<i>Cymbella ventricosa</i> Assoc.
ibid.	VII	7.3	40.0	—	30	<i>Achnanthes exigua</i> Assoc.
ibid.	VIII	7.3	40.0	—	30	<i>Achnanthes exigua</i> - <i>Pinnularia Kneuckeri</i> Assoc.

New additional species to Japan: *Amphora strigosa*, *Ceratoneis arcus* var. *vaucheriae* f. *kamtchatica*, *Cocconeis placentula* var. *Rouxii*, *Navicula cryptocephaloides*, *Navicula decussis*, *Navicula graciloides*, *Navicula incognita*, *Navicula menisculus* var. *sinica*, *Neidium iridis* f. *vernalis* and *Surirella elegans* f. *constricta*.

New additional species to Japanese thermal flora: *Achnanthes brevipes*, *Achnanthes crenulata*, *Ceratoneis arcus* var. *vaucheriae*, *Cymbella sumatrensis*, *Gomphonema constrictum* var. *capitata*, *Gomphonema longipes* var. *subclavata*, *Gomphonema parvulum* var. *micropus*, *Gomphonema tetrastigmata*, *Navicula oppugnata*, *Neidium dubium*, *Pinnularia borealis*, *Pinnularia Karelia*, *Stephanodiscus astraea*, *Surirella biseriata* var. *bifrons*, *Surirella robusta* and *Surirella robusta* var. *splendida* f. *punctata*.

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トフンタケ *Psilocybe coprophila* Fr. の極性について*

木 村 勘 二**

Katsuji KIMURA^{**}: On the Polarity of *Psilocybe coprophila* Fr.^{*}

1956年9月16日受付

トフンタケ (兎糞茸) *Psilocybe coprophila* Fr. は普通, ウサギの糞の上に生じるヘテロタリックの帽菌である。本菌の極性は Gilmore (1926) 及び Brodie (1935) によれば二極性であるが, 一方 Vandendries (1937 a, b) は本菌は四極性であると述べている。このように同一種の中に二極性と四極性の二つの系統が存在することは, 帽菌類の

他の若干種においても報告されている (Whitehouse 1949 a, Quintanilha & Pinto-Lopes 1950)。Aschan (1954) はこれらの中で *Corticium coronilla* 等には二極性と四極性の両系統の間に分類学的に疑問の点があるが, *Psilocybe coprophila*, *Radulum orbiculare*, *Anellaria separata*, *Hypopholoma fasciculare* 等には, このような分類学上

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のあいまいさはなく、これらの菌の極性については今後更に追究するべきであると述べている。著者は本邦産の *Psilocybe coprophila* で調べたところ、本菌の極性に関して一つの見解を得たのでここに報告する。

材料と方法

本実験には K, T の 2 系統を用いた。K 系統は長尾研究所の椿啓介氏が 1952 年 1 月東京奥多摩で採集されたもので、菌柄より分離した複相菌糸を 1954 年 3 月に送っていただいた。この複相菌糸を培養して子実体を作らせ、その中の 1 個、Ka から単孢子培養菌糸 20 個を得た。T 系統は著者が 1952 年 9 月、鳥取市で採集したもので、1 個の野生子実体 Tw から単孢子培養菌糸 14 個を得ると同時に多孢子培養により複相菌糸をも得た。この複相菌糸を培養して、生じた子実体の 1 個、Ta から単孢子培養菌糸 20 個を得た。

これらの単孢子培養菌糸の組合わせ培養はすべて試験管内斜面寒天培養基上で行い、30°C で 5~

7 日培養した後、両菌叢の境界附近の菌糸をとって clamp connection の有無を鏡検した。

本菌の子実体形成は極めて容易で、複相菌糸を三角瓶又は試験管内の寒天培養基に植えて 30°C に保つ時は 8~12 日で多数の子実体が生じた。これらの子実体は菌傘の直径が 2~5 mm で野生のものよりも遙かに小さいか、或いは塊状の不定形であったが、胞子は正常で且つ夥しく生じた。なお本菌は複相菌糸だけでなく、単孢子培養菌糸及び clamp connection が見られなかった組合わせ培養菌糸にも、しばしば上記のような子実体が生じたが、複相菌糸に生じたものに較べて胞子の量が非常に少かった。

本実験に用いた培養基はすべて馬鈴薯煎汁寒天培養基であり、単孢子分離は西門氏法 (1938) によった。

実験結果と考察

まず T 系統の野生子実体 Tw から分離した 14 個の単孢子培養菌糸、2 個ずつのすべての組合わ

Table 1. All posible pairings of fourteen monosporous mycelia isolated from a wild fruitbody of T-strain, Tw.

	I						II							
	1	2	4	5	6	7	3	8	9	10	11	12	13	14
I	—	—	—	—	—	—	±	±	±	±	±	±	±	±
II	±	±	±	±	±	±	—	—	—	—	—	—	—	—

The sign (±) indicates the presence of a few clamp connections, and the sign (—) the absence of them.

Table 2. All possible pairings of twenty monosporous mycelia isolated from an artificially cultured fruitbody of T-strain, Ta.

	I							II				III							IV	
	1	5	6	10	11	14	17	2	7	15	20	3	4	9	12	13	16	19	8	18
I	—	—	—	—	—	—	—	+	+	+	+	±	±	±	±	±	±	±	—	—
II	+	+	+	+	+	+	+	—	—	—	—	—	—	—	—	—	—	—	±	±
III	±	±	±	±	±	±	±	—	—	—	—	—	—	—	—	—	—	—	+	+
IV	—	—	—	—	—	—	—	±	±	±	±	+	+	+	+	+	+	+	—	—

The sign (+) indicates the presence of many clamp connections. The (+)-mycelia grew faster than both of (±)- and (—)-mycelia, but there was no difference in the growth rate between (±)- and (—)-mycelia. Oidia were produced on (±)- and (—)-mycelia, but not on (+).

数見られても土の菌糸は、+の場合のような正常な複相菌糸ではないものと見たい。

Aschan (1954) は *Collybia velutipes* の研究で、clamp connection の有無だけによつて極性の如何を決めることの不可を論じているが、本菌の極性も clamp connection の数の多少を論ぜずに、ただ単にその形成の有無だけから第 1, 2, 3 表の結果を判断するならば二極性であるが、子実体にできた胞子の交配型の種類から見て、真の複相菌糸といえるのは+の場合だけであると考えられるから、本菌は四極性であると著者は見たい。また、他の帽菌において複相菌糸の生長速度が単相菌糸のそれにまさっていることがあるが(西門, 山内 1935, 木村 1952 a, 1954), 本菌において+の菌糸が土のものよりも生長速度が早く、土、一両者の間にはその差がないこと、及び普通、帽菌類で単相菌糸にだけ生じる oidia が土にでき+には見られないこと等から推しても四極性であるといえよう。

次に Ka 子実体の 4 交配型と Ta 子実体のそれとの組合わせ培養、及び Tw 子実体の 2 交配型と上記 2 子実体の各々の 4 交配型との組合わせ培養の結果は、それぞれ第 5, 6 表のようである。

Table 5. Pairings of the four mating types derived from Ka with those from Ta.

		Ta				
		I	II	III	IV	
		A ₄ B ₄	A ₃ B ₁	A ₃ B ₄	A ₄ B ₁	
Ka	I	A ₁ B ₁	+	±	+	±
	II	A ₂ B ₂	+	+	+	+
	III	A ₁ B ₂	+	+	+	+
	IV	A ₂ B ₁	+	±	+	±

これらの結果と前の第 1, 2, 3 表とを合わせて考えると、いま Ka 子実体の I, II, III, IV の交配型をそれぞれ A₁B₁, A₂B₂, A₁B₂, A₂B₁ とすると、Ta 子実体の I, II, III, IV の各々は A₄B₄, A₃B₁, A₃B₄, A₄B₁ となり、K 系統 A₁A₂B₁B₂ と T 系統 A₃A₄B₁B₄ との間に B₁ という共通の因子が存在することになる。また、Tw 子実体の I, II の交配型はそれぞれ A₄B₁, A₃B₁ であり、14 個の単孢子培養菌糸が偶然にも、これら 2 つの交配型のどちらかに属するものばかりであったといえる。

このように各交配型を定めると、組合わせ培養で A 因子、B 因子が共にヘテロの場合は+、A 因子がヘテロで B 因子がホモの場合は土、A 因子がホモで B 因子がヘテロの場合、及び A 因子、B 因子が共にホモの場合は-を示すものと考えられる。

Whitehouse (1949 b), Aschan (1954) 等の述べるように菌類では二極性のものから四極性のものが進化して出てきたと考えられるが、著者が材料として用いた本菌の 2 系統は、この過程の模様を示すものではあるまいか。すなわち、A 因子がヘテロで B 因子がホモの場合、少数ながら clamp connection を形成し、A 因子がホモで B 因子がヘテロの場合は、その形成を全く見ないということは、本菌に、かつて A 因子だけが関与していた二極性の時代があり、これに B 因子が漸らしく加わって四極性に変っていったことの示唆と見たい。また、K, T の 2 系統の間に共通の因子 B₁ が存在するが、このような産地を異にする系統間の共通因子は四極性のウシグソヒトヨでも稀に見られたことである(木村 1952 b)。しかしウシグソヒトヨの場合は、産地が約 10 軒隔てた系統の間にその例が見られただけで、産地が岡山県と滋賀県、或いは岡山県と新潟県のような遠隔の系統

Table 6. Pairings of the two mating types derived from Tw with each four mating types from Ka and Ta.

		Ka				Ta				
		I A ₁ B ₁	II A ₂ B ₂	III A ₁ B ₂	IV A ₂ B ₁	I A ₄ B ₄	II A ₃ B ₁	III A ₃ B ₄	IV A ₄ B ₁	
Tw	I	A ₄ B ₁	±	+	+	±	-	±	+	-
	II	A ₃ B ₁	±	+	+	±	+	-	-	±

の間では、このようなことは認められなかった。これに対してトフンタケでは約500株も隔てた東京、鳥取の2系統間に共通因子 B_1 が存在し、このこともB因子の極性への参加の時期が、まだ新しいことを意味するものではあるまいか。

以上の考えが許されるならば、本菌が二極性から四極性になったのは比較的新しいことでありまた、その進化の様相も地域によって異なると思

われるから、Gilmore, Brodie の見た系統は実際に二極性であったのであろうし、Vandendries のそれは四極性であったのであろう。そして著者の見た2系統は共に四極性ではあるが、過去の二極性の時代の姿を、なお幾分留めるものといいたい。

終りに本菌の同定及び和名命名の労をとられた上に、東京産の系統をお送り下さった小林義雄博士並びに椿啓介氏に深く感謝する。

Summary

Determination of the polarity of *Psilocybe coprophila* Fr. was made, using two strains, K and T, collected in Japan. This fungus has been suggested to include both the bi- and tetrapolar strains.

Judging only from the results of test for clamp connections, but ignoring the difference in the number of them, in all possible pairings of monosporous mycelia isolated from a fruitbody, this fungus may be said to be bipolar. The clamp-bearing mycelia can, however, be subdivided into two groups. The one is characterized by many clamp connections, producing normal fruitbodies, and the other by only a few clamp connections, producing haploid fruitbodies bearing spores of the same mating type. The latter group can hardly be regarded as real diploid mycelia, because of the appearance of haploid fruitbodies which often develop on the monosporous mycelia of this fungus. From this point of view, the polarity of this fungus is thought to be tetrapolar.

In the pairings of monosporous mycelia, when both A- and B-factors are different, the number of clamp connections is many, but when A-factors, but not B-factors, are different, it is few, and when B-factors, but not A-factors, are different, or when both A- and B-factors are identical, no clamp connection is formed.

It was found that one common factor, B_1 , was involved in the two strains which were collected from two places about 500 km apart from each other.

The regular formation of clamp connections, though it is few in number, in the illegitimate combinations in which B-factors, but not A-factors, are identical, and also the existence of one common factor, B_1 , in the remote places seem to suggest the evolutionary course from bipolarity to tetrapolarity in this fungus.

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本 会 記 事

役 員 移 動

会長選挙
会則第 8, 9 条および付則第 3 第 1 条によつて行われた会長改選の投票は 3 月 15 日に投票を締切り, 同 16 日開票しました。その結果は次の通りとなり, 現会長服部静夫氏が再選されました。なお, 任期は 32 年 4 月 1 日から 2 カ年です。

服 部 静 夫	1 3 9
郡 場 寛	5 6
木 原 均	5 4
篠 遠 喜 人	3 4
松 浦 一	2 7
そ の 他	3
<hr/>	
合 計 投 票 数	3 1 3

評議員選挙

会則第 8, 9 条および付則第 3 第 2 条によつて行われた評議員改選の結果は各支部から 3 月 15 日までに本部に報告され, 次の 25 名の方々が評議員となりました(支部別 アイウエオ順)。なお, 任期は 32 年 4 月 1 日から 2 カ年です。

- 北海道支部 (定員 2 名) 宇佐美正一郎, 山田幸男。
- 東北支部 (定員 2 名) 木村有香, 神保忠男。
- 関東支部 (定員 8 名) 伊藤洋, 大槻虎男, 小野記彦, 高宮篤, 前川文夫, 三輪知雄, 和田文吾, 亘理俊次。
- 北陸支部 (定員 2 名) 柴田万年, 正宗厳敬。
- 中部支部 (定員 2 名) 熊沢正夫, 島村環。
- 近畿支部 (定員 4 名) 芦田譲治, 今村駿一郎, 北村四郎, 新家浪雄。
- 中国四国支部 (定員 3 名) 猪野俊平, 下斗米直昌, 堀川芳雄。
- 九州支部 (定員 2 名) 小島均, 細川隆英。

報 告

- 日本学術会議関係諸委員の改選にあたり, それぞれ当会会長宛候補者推薦の依頼がありましたので, 下記の通り推薦致しました。
- 日本学術会議中央選挙管理会第 4 部植物学関係委員 (評議員の投票によつて決定): 和田文吾, 前川文夫。
- 同 生理科学研究連絡委員会委員 (締切の期日が切迫していたため, 会長が関東支部選出の評議員と相談の上決定): 服部静夫, 高宮篤, 森健志。
- 同 微生物学研究連絡委員会委員 (締切の期日が切迫していたため, 会長が関東支部選出の評議員と相談の上決定): 大槻虎男, 田宮博。

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- 茨城大文理 水戸市渡里町

支 部 通 信

北 海 道 支 部

2 月例会 (2 月 23 日, 於北大理植) 豊国秀夫: チチブリンドウについて。佐保 貴: エンレイソウの種間雑種について。

東 北 支 部

第 9 回支部大会 (8 月 19 日, 於岩手大学芸) 千田貞蔵: *Salix pentandra*, *S. fragilis*, *S. triandra* および近縁種の葉の比較解剖。中沢潤: ムラサキツユクサ 3 倍体植物について。永井政次,

小林隆二：特殊水棲菌類に属する *Blastocladia* の観察。松田孫治：ツキヨダケとスギヒラタケについて。樋口利雄：福島県の蘚類（県南のフロラ）について。菊地政雄：三陸沿岸地方産キスミレに関する新考察。森 邦彦，永原最好：ウゴシホギク自生地の植物生態学的観察。太田 哲：荒島の植生考。伊藤安次：大館市芝谷地の湿原植物について。石塚和雄，藤原純一，渡辺満夫：岩手県2, 3 湿原の花粉分析。飯泉 茂，黒崎順二：農場内における牧草のエスケープについて。飯泉 茂：地獄沼毒水（八甲田山）の植物に与える影響について。江刺洋司：シュウカイドウの無性芽形成 1. 日長性との関係。山井秀夫：トリプトファン分解酵素系について。

関東支部

12 月例会（12 月 15 日，於東大理植）塙 順：ゴマの胚の手術による双生葉の形成について。三井 旭*，高島士郎，田宮 博：緑葉における光化学的隣転移反応。

1 月例会（1 月 26 日，於東大理植）今井百里江子：糸状菌の蠟上発育について（第2報）菌の好稠性と好蠟性との関係について。石川茂雄：暗発芽種子クロタネソウの発芽促進機構について。

2 月例会（2 月 16 日，於東大理植）宝月欣二，大島康行*，翠川文二郎，坂本充，手塚泰彦，本谷勲，木村允：キクイモ人工群落の生長解析。保井コノ：ムラサキツユクサの male gametophyte の発生 I. Microspore の生長。

北陸支部

第5回総会および第19回例会（5月13日）瀬嵐哲夫：コウジカビの heterozygous diploid。鈴木米三，高桑昇：ハシリドコロの葉のフェノール酸化能について（予報）。玉井直人，西田晃二

郎：大麦幼苗の P^{32} 転移に及ぼす明暗の影響。小野寺正二：トチカガミ根毛の原形質流動（I）。

第20回例会（8月18～20日，エックスカーション）白山噴泉塔附近。

第21回例会（9月15日）斎藤寛昭：日野川における河原植物群落についての生態学的研究。香室昭円：湯水期を有する湖沼の植物生態学的研究 V. 霞ヶ池における湯水後の湖盆環境の中，傾斜気温及び土壌湿度について。

第22回例会（11月17日）香室昭円：植物群落における種類数と面積との関係（予報）。鈴木米三，高桑昇：ハシリドコロの L-グルタミン酸脱炭酸作用について。進野久五郎：北陸にひろがりつつある若干の帰化植物について。

第23回例会（2月16日）香室昭円：ヨシ沼沢の植物生態学的研究 第2報（予報）土壌要因について。正宗厳敏：奄美大島旅行談（天然色スライド使用）。

近畿支部

例会（2月3日，於阪大理，動物学会と共催）植物学関係。信夫隆治：Whirl を形成する放線状菌の新種 2, 3 について。梅崎勇：藍藻類 2 属 *Brachytrichia* と *Kyrtuthrix* の分類の再検討。高木虎雄：竹笹科の実生の変異。根来健一郎：浮遊生物相より見たる琵琶湖と余呉湖の比較。末松四郎：寄生性緑藻 *Cephaeluros virescens* の培養型について。真山三賀雄：放射状菌 *Streptomyces* の血清学的類縁性。

九州支部

第43回例会（2月9日，於九大理）西村昭治：キョウチクトウの花色について。茅野博：ノヒメユリ胚嚢母細胞における過剰染色体の選択的分離。田中友安：アメリカの植物（幻燈）。

Developmental Mechanics of Fucaceous Algae IV. Morphogenetic Movement of *Coccophora* Eggs

by Singo NAKAZAWA*

中沢信午*: フークス科植物の発生力学 IV. スギモクの卵の形成運動

Received September 29, 1956

It is known that in animal eggs their primary volume is as a rule kept up without being changed till the blastula stage in spite of the successive occurrence of cleavage (2). In *Fucus* eggs, it is also reported that while the cleavage proceeds after fertilization the whole volume of the egg is constant till it becomes composed of several or more cells (4). The volume, however, was not measured precisely. Herein, a measurement was made by the present writer on *Coccophora* eggs. The result is introduced here with some discussions from the standpoint of revealing the mechanism of polarity determination.

In April, 1953, some individuals of *Coccophora Langsdorfii* were collected from a nearby reef at Asamushi. Eggs discharged in glass vessels were artificially fertilized, then used for the present investigation. Five fertilized eggs were placed in a petri dish containing sea-water, being arranged side by side so that those were observed within the same field of the microscope. The outline of these eggs were precisely drawn with *Zeichenapparat*. After that, the dish was covered with a glass plate with care not to move these eggs, and left as it was under the lens of a microscope. While inspecting 24 hours later, it was found that these eggs did not change their relative positions, so that even if a slight transformation occurred in the same egg, it was easily discovered by means of drawing in the same method as before. However, as to the fertilization cone which was discovered by Abe (1), it was not always observable in each egg, therefore it was omitted from the drawing. The two drawings on the different stages, just after and 24 hours after fertilization, were photographed. The pictures were enlarged, then some necessary factors for calculation of the egg volume were measured on those pictures.

The form of the egg is spherical or ovate, a little pointed on one end (Fig. 1). Its volume is easily calculated according to pappus-Guldin's theorem. That is, let the plane figure of the right (or left) half of a vertical section of the egg containing its longitudinal axis y be denoted by a (Fig. 2), its area by A , the distance to y from the centroid of a by \bar{x} , and the volume of the egg obtained from the rotation of a around y by V , then

$$V=2\pi\bar{x}A.$$

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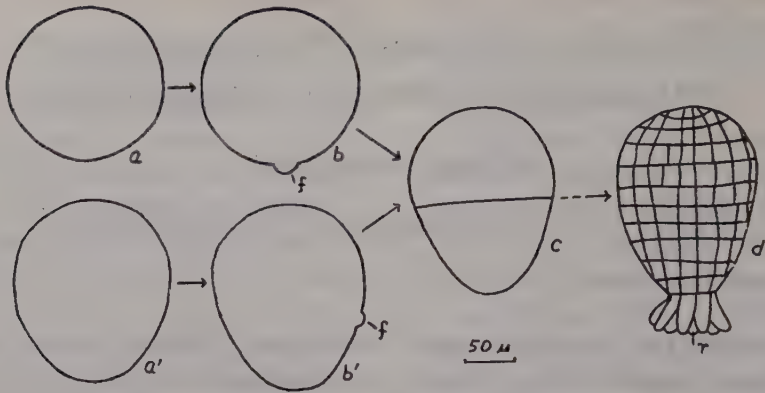


Fig. 1. Schematic illustration of two different types in the polarity determination of *Coccophora* eggs. a-d) polarity determination in spherical eggs; a'-d) the same in ovate eggs. a, a') before fertilization; b, b') just after fertilization; c) the first cleavage; d) young embryo forming rhizoids. f, fertilization cone; r, rhizoids.

In finding the centroid, the figure enlarged on a piece of homogeneous paper was cut out and it was placed on the top of a pencil erected vertically. Then, when the figure balanced, the sustaining point was marked with the supporting tip of the pencil by pressing the figure downwards. The area of the plane figure was calculated from the weight of the marked paper comparing it with that of another

Table 1. Measurement of *Coccophora* eggs for calculating the volume.

Egg	Time after fertilization	\bar{x} in μ *	A in μ^2 *
1	10 min	21.5	2574.4
	24 hr	17.7	2926.6
2	10 min	20.5	2881.6
	24 hr	20.9	3021.9
3	10 min	14.8	3248.9
	24 hr	16.5	3248.9
4	10 min	15.9	2866.7
	24 hr	17.7	3057.8
5	10 min	17.6	3822.3
	24 hr	17.7	4013.4

* Explained in the text.

Table 2. Volume V , and its increase ΔV in time after fertilization of *Coccophora* eggs, calculated from Table 1.

Egg	Time after fertilization	V in μ^3	ΔV in μ^3	ΔV in %*
1	10 min	347597.4		
	24 hr	325309.0	-22288.4	-6.4
2	10 min	371012.4		
	24 hr	396630.3	+25617.9	+6.9
3	10 min	305272.7		
	24 hr	335936.2	+30663.5	+10.0
4	10 min	286116.6		
	24 hr	339721.5	+53604.9	+10.0
5	10 min	422369.6		
	24 hr	445888.7	+23519.1	+5.0

* $(\Delta V/V \text{ in 10 min after fertilization}) \times 100$

piece of the same paper whose weight and area relation was already known. Result of the measurement of those factors necessary for the volume calculation is presented in Table 1, and the volume (V) and its increase (ΔV) are shown in Table 2. In this calculation, if each procedure, the drawing, enlargement on paper, measuring weight, determination of the centroid, etc. contains 1 per cent error, which is quite probable, then at least over 5 per cent of the calculated volume must be taken into account to be the probable error. In this respect, it seems from the table, that while the matter is a little different from each other according to the individual, when averaged, the actual volume increase is very little in spite of the remarkable transformation. In some eggs, like egg 1 in the table, the volume was decreased rather than increased. One of some remarkable features appearing in the transformation is the elongation along the longitudinal axis. It is indicated in ratio between the longitudinal axis y and the width x of the egg (Tab. 3). As the error in the measurement is much less by this time owing to the

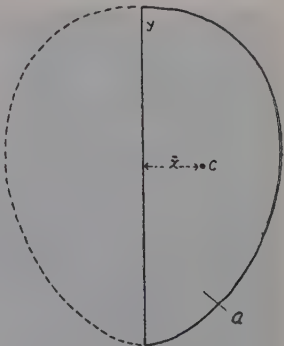


Fig. 2. Illustration of the factors to be measured for calculating the egg volume. a , The right (or left) half of a longitudinal section containing the major axis y ; \bar{x} , distance to y from c , the centroid of a .

Table 3. Change of the length y , width x , and their ratio y/x of *Coccophora* eggs in 24 hours after fertilization.

Egg	Time after fertilization	x in μ	y in μ	y/x
1	10 min	50.4	114.0	2.2
	24 hr	46.7	145.8	3.1
2	10 min	50.4	127.1	2.5
	24 hr	46.7	140.2	3.0
3	10 min	62.4	125.0	2.0
	24 hr	65.5	125.0	1.9
4	10 min	65.4	99.7	1.5
	24 hr	65.4	105.4	1.9
5	10 min	70.1	116.8	1.6
	24 hr	72.3	116.8	1.6

simpler procedure than by the volume calculation, the table is much more reliable. Another feature which accompanies the egg elongation is the asymmetric sharpening of the egg form towards the one extremity of the longitudinal axis. In consequence of this transformation the egg becomes more ovate, pointed on the one end.



Fig. 3. Side view of a fertilization cone (fc) being raised on the surface of a *Coccophora* egg.

The pointed part in a later stage forms the rhizoid primordium (Fig. 1). Sometimes the elongation is not remarkable like eggs 3 and 5 in Table 3. Even in such a case, however, the asymmetric sharpening does occur without fail. Thus the transformation, *i.e.* a morphogenetic movement, takes place almost without varying the volume. Besides, inspecting the drawings and Table 3, it is known that the asymmetric sharpening is attributed to a protrusion of the one extremity of the longitudinal axis rather than to the new addition of protoplasm. This strongly implies an eccentric change of the surface energy, that is, a partial decrease of the surface tension in that part.

It was revealed by observations, that the polarity of *Coccophora* eggs appeared with a morphogenetic movement, viz. transformation from spherical to ovate. Ac-

cording to Abe (1) the center of the transformation is determined at the entrance point of the spermatozoid raising a fertilization cone. However, so far as the writer's observations are concerned, this occurs merely when the primary form of the eggs is spherical. But in these different eggs which are originally of ovate form, the primary axis is not modified by the fertilization cone while a temporary fertilization cone is sometimes confirmable in observation (Fig. 3). This indicates that what takes the leading part in the polarity determination is the morphological axis of the egg. That is, it seems that in spherical eggs, the primary axis is so small that it is surpassed by the raising of a fertilization cone, forming a new axis which takes part in the polarity determination. But when the primary axis is large enough, as in ovate eggs, it is not surpassed by the fertilization cone wherever it arises, so that the former is not modified in the development. Therefore, it is natural that if the egg is forcibly transformed, the artificial axis enacts the title-rôle in the determination (7). A similar experiment is also reported in *Fucus* eggs (10). As aforesaid, the morphogenetic movement of the egg of this alga implies an eccentric change of the surface energy. This seems valid considering the writer's preceding experiments. That is, centrifuging reveals that the polarity determination in *Coccolporea* egg is not controlled by the arrangement of intracellular materials (5). However, it is autonomically determined if the egg is ceaselessly rotated irregularly in sea-water, viz. excluded the gradient of external conditions (9). These two experiments indicate that the polarity determination is attributed to a cortical or a surface differentiation. Besides, the fact of permeability gradient along the major axis, appearing after fertilization in the highest degree in the pointed part (6, 8), verifies a surface differentiation.

Summary

The same eggs of *Coccolporea Langsdorffii* were measured at two developmental stages, just after and 24 hours after the fertilization. As a result, it was revealed that their volume was almost constant in spite of their transformation from spherical to ovate, pointed towards the one extremity of the longitudinal axis. This implies the partial decrease of the surface tension on the pointed side. The fertilization cone in the polarity determination is discussed.

The writer's sincere thanks are due to Dr. Arika Kimura, Tohoku University, for his kind support for the present research.

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Promotion of Leaf Growth and Acceleration of Stem Elongation by Gibberellin*

by Susumu KURAISHI** and Tohru HASHIMOTO**

倉石晉**・橋本徹**： ギベレリンによる葉および茎の生長促進作用*

Received October 20, 1956

Introduction

Gibberellin, a metabolic product of *Gibberella fujikuroi* which causes "Bakanae" symptoms (9), induces abnormal growth of rice plants. Many works have been reported about the physiological actions of gibberellin, using intact or excised materials. The most striking growth stimulation due to treatment with gibberellin is stem elongation and this effect of gibberellin has been observed on many kinds of plants (1, 2, 5, 6, 10, 11 and 12). With leaves, however, growth acceleration due to treatment with gibberellin has not always been obtained. Yabuta *et al.* found that in experiments using treated tobacco and untreated ones as controls, the largest leaf was always found among treated plants (10), and that the mean of leaf area of once treated tobacco plants was larger than that of untreated one (11). In case of tea, the growth of lower leaves of treated shoot was accelerated by gibberellin, but the growth of upper leaves was never affected (12). Hayashi and Murakami (5) also observed the definite growth accelerating effect of gibberellin on the youngest part of the young leaves of oat and barley. Remarkable promotion of leaf length and decrease of its width in wheat (1) have been observed.

It was not clear whether these phenomena caused in plant by gibberellin were due to direct or indirect action. In the present works, the effects of gibberellin on growth of leaf are investigated using excised leaf and intact leaf. Also the mode of action of gibberellin is compared with that of kinetin, reported lately as effective on leaf growth (8). For the study of gibberellin transport, stem growth of intact plant is also observed.

Materials and Methods

Raphanus sativus (the variety Risô Daikon) was selected for the study of leaf growth and the same method of cultivation as reported in previous papers (7 and 8) was applied to grow the materials. *Pisum sativum* (the variety Alaska pea) was employed for the study of leaf growth and stem growth. *Pisum* seeds were soaked in tap water for six hours and planted in coarse quartz sand in green house

* 本研究の一部は文部省科学研究費(総合研究課題番号 4071)を用いて行われた。

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and watered twice a day with Boysen-Jensen's solution. On sunny days, they were covered with a fine bamboo-blind to avoid the strong sunlight, under which the internodes become too short.

Raphanus leaves were cut off from the base of lamina, when the area of the first foliage leaves became large enough for the experiment. In the case of Alaska pea, when the fifth internode became two cm. long, the plants were moved into the darkroom for starvation and were kept there about eighteen hours. After the starvation, the fifth leaves were cut off and disks 0.5 cm. in diameter were punched out from the leaves with a sharp cork borer. After washing the *Raphanus* leaves and *Pisum* leaf disks separately, the former were floated on twenty five ml. of culture medium containing basal minerals (7 and 8) and two per cent of sucrose in Petri dish of nine cm. in diameter, and the latter were floated on ten ml of same medium in Petri dish of five cm. in diameter. In the former case ten leaves were floated and in the latter fifteen disks were used in each dish. The dishes were incubated at 30°C under 1000 lux for twenty hours. All the experiments were repeated two or three times and two Petri dishes were used for each different case in the experiments. After the incubation, the fresh and dry weights of leaves and leaf area were measured, as shown in previous papers (7 and 8).

For the experiments of stem growth, *Pisum* was used as material. Sections of 0.5 cm. in length were cut off with a two bladed cutter from the seedlings from which the leaves were cut off for the experiment of leaf disks. They were floated in distilled water and each ten of them were picked up at random and floated on the surface of ten ml. of medium consisting of ten times diluted McIlvain's buffer solution (pH 4.8, optimum for stem growth), with two per cent of sucrose in Petri dishes, five cm. in diameter. The dishes were incubated for eighteen hours at 27°C under 4000 lux. After the incubation, the length of sections, fresh weight and dry weight were measured. Visible contamination with microorganisms did not occur within twenty hours incubation.

The growth accelerating effect of gibberellin for the intact plants was studied using Alaska pea, which was grown under the same conditions as mentioned above. Before the fifth internode appeared in the plants, lanolin paste of 0.1 per cent gibberellin was smeared on the lower surface of the stipule of the fourth node. Then the stem and petiole length and the leaf fresh weight were determined for a week with an interval of twenty four hours between each determination.

The light sources used were three 20 Watt Mazda fluorescent tubes of "natural day light" in the case of 1000 lux illumination, and ten 40 Watt tubes of "White light" in the case of 4000 lux.

The used gibberellin A mixture was kindly provided to the authors by Prof. Y. Sumiki and his co-worker of University of Tokyo. Kinetin was offered by Prof. F. S. Okumura of University of Tokushima. The authors wish to express their deep gratitude to them.

Results

Effects of gibberellin on the growth of *Pisum* plant

Alaska pea was selected to study the correlation of leaf growth acceleration and stem growth acceleration by gibberellin. In each experiment 160 uniform-shaped plants were selected from about four thousand *Pisum* plants. The plants treated with gibberellin and the untreated ones used as controls were grown in green house, and the length of the stem internode and petiole and fresh weight of leaves including plumule (fresh weight is determined as an index of leaf size) were determined every day for a week (Fig. 1).

Fresh weights of total of leaves of one plant shown in Fig. 1A are the means of ten *Pisum* plants. Repeated experiments gave results showing almost the same tendency; as an example the experiment held from July 15th to July 22nd (1956) is shown in Fig. 1. As it can be seen in Fig. 1C, the growth promoting effect of gibberellin migrated from lower internode to upper internode and disappeared in the seventh internode. The promoting effect was observed in the petioles. The upper two petioles were omitted from the figure to avoid complexity. On the contrary, in leaves, gibberellin inhibited growth (fresh weight), though the extent of inhibition was small.

For the investigation of the direct effect of gibberellin, it seemed necessary to use excised plant parts in order to avoid the influence of other parts of the plant. Therefore, the disks of fifth leaves and the fifth internodes were cut off from *Pisum* plants and the effects of gibberellin on disks of *Pisum* leaves and excised internodes were observed (Table 1 and 2). As shown in Table 1, gibberel-

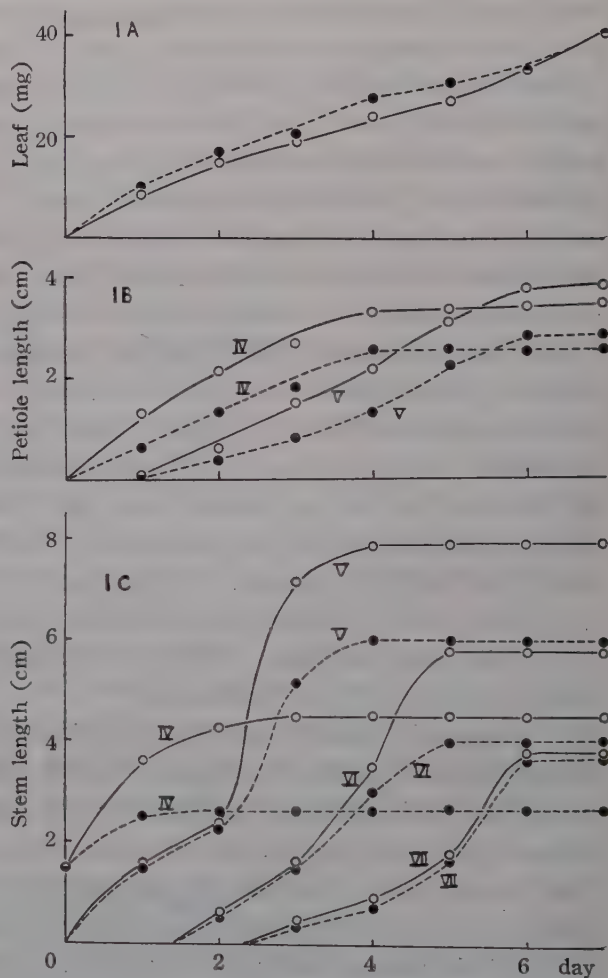


Fig. 1. Growth of intact *Pisum* after gibberellin treatment (solid line) and growth of control (broken line). Fig. 1A is the growth of leaf; 1B, petiole; 1C, stem. The Roman numerals indicate the numbers of stem internode and petiole. The length of stem and petiole is shown in cm; the fresh weight of leaves including plumules is in mg.

Table 1. The growth of excised *Pisum* internode in the solution containing 10 mg. of gibberellin per litre. Stem sections were incubated in the medium which consisted of two per cent of sucrose and McLevaine's buffer solution (pH 4.8) for 18 hours at 27°C under 4000 lux. Growth is shown as per cent of the initial values. The figures are averages of each 10 sections.

	Control	Gibberellin (10 mg./l.)
Length	116	124
	114	123
Fresh weight	121	145
	124	133
Dry weight	143	157
	143	142

Table 2. Growth promotion of *Pisum* leaf disks by gibberellin. The disks were floated on the standard medium for 20 hours at 30°C under 1000 lux. Growth is shown as per cent of the initial values.

	Control	Gibberellin (10 mg./l.)
Leaf area	140	195
	140	203
Fresh weight	151	188
	154	191

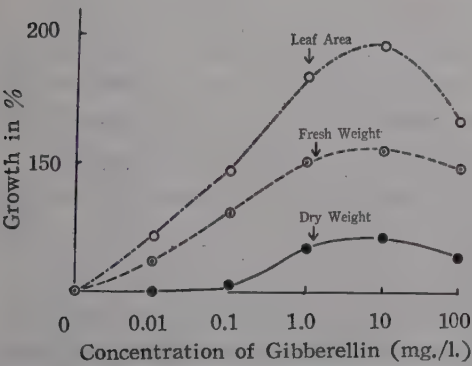


Fig. 2. The growth of excised *Raphanus* leaf in gibberellin solutions of various concentrations under the illumination of 1000 lux. Growths are shown as percentage of controls; chain dotted line: growth in area, broken line: growth in fresh weight, solid line: growth in dry weight.

lin stimulates the elongation of excised green stem as well as that of the stem of intact plant. Table 2 shows that the growth of leaf disks were remarkably accelerated by the treatment of gibberellin, though the intact *Pisum* leaf growth could not be stimulated by gibberellin.

Effect of gibberellin on the growth of *Raphanus* leaf

Although a remarkable growth promotion was observed in disks of *Pisum* leaf, the further experiments were performed using excised *Raphanus* leaf, as *Raphanus* leaf is often used to investigate the physiology of leaf growth by some workers (3, 4, 7 and 8).

Gibberellin was dissolved into the medium in various concentrations ranging from 100 mg./l. to 0.01 mg./l. and the effect of gibberellin on leaf growth of *Raphanus* was investigated (Fig. 2). The experiments were performed in both light and dark conditions. Even in dark, gibberellin stimulated leaf growth, and the results of the experiments in darkness were very similar to those of the experiments in illuminated condition. Any of the results obtained about fresh and dry weight and leaf area showed that leaf growth is stimulated by gibberellin as far as these experiments are concerned. The optimum concentration of gibberellin for *Raphanus* leaf growth was 10mg./l. Thereafter all the experiments with excised materials were done at concentration of 10 mg./l. As shown in Fig. 3, the growth promoting effect of gibberellin appeared within three hours after the beginning of gibberellin treatment.

Sump method was used to observe the shape of the epidermal cells of leaves treated with gibberellin. The leaves for this study were the same materials used in the experiments for Fig. 3. The upper surface of leaves: initial leaves, gibberellin treated (24 hours) leaves and controls (24 hours), were replicated on small celluloid plates with a solution of Sump No. 2 and observed with a microscope. Only a great enlargement was observed in epidermal cells; neither remarkable increase of cell number nor visible change of shape could be observed.

The mode of action of gibberellin and kinetin on leaf growth of *Raphanus*

Kinetin has been known to have remarkable stimulating effect upon growth of leaf (8). The

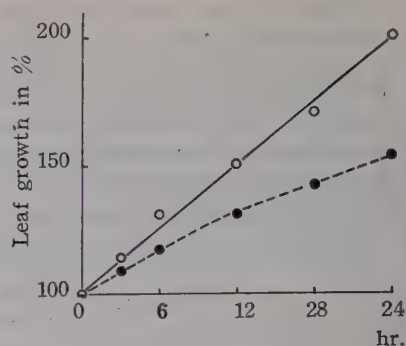


Fig. 3. The growth of excised *Raphanus* leaf in gibberellin solution (10 mg./l.) in relation to time. The solid line shows the growth of gibberellin treated leaf and the broken line indicates that of control. The leaf was incubated at 30°C under 1000 lux. The growth is shown as percentage of initial values.

Table 3. The mode of action of gibberellin and kinetin on *Raphanus* leaf growth. Growth is shown as per cent of the initial values. The leaves were floated on the standard medium at 30°C under 1000 lux for 20 hours. Gibberellin and kinetin were dissolved in the concentration of 10 mg./l. and 1 mg./l., respectively.

Leaf area of used materials		6.0 cm ² .	1.0 cm ² .
Control	Fresh weight	133	140
	Leaf area	110	128
Gibberellin	Fresh weight	147	153
	Leaf area	159	186
Kinetin	Fresh weight	161	180
	Leaf area	150	164
Gibberellin+Kinetin	Fresh weight	180	203
	Leaf area	169	193

following experiments were performed to make clear whether synergistic action of these two compounds exists or not. The optimum concentrations of gibberellin and kinetin for leaf growth were 10 mg./l. and 1 mg./l. (8), respectively. As materials, the leaves of two different sizes (old leaves with area of 6.0 cm². each and young leaves of 1.0 cm². each) were used to study the difference in the effectiveness of gibberellin according to growth stage.

As shown in Table 3, both gibberellin and kinetin individually promote the ex-

pansion of leaf area and the increase of fresh weight of leaf, not only in young leaf, and the two compounds together cause increase in leaf area and fresh weight larger than when only one of the compounds is used. As to the mode of action of gibberellin and kinetin, the following may be stated: gibberellin promotes more the expansion of area than the increase of fresh weight, however, kinetin accelerates the increase of fresh weight rather than leaf area.

Discussion

The effect of gibberellin on the growth of leaf on intact plant has been reported by many investigators: a small acceleration in some species, no acceleration in others and sometimes even inhibition were observed. Using excised leaf, however, Hayashi and Murakami (5) observed accelerating effect of gibberellin on very young part of leaves. In the present experiments it has become evident that gibberellin has a remarkable accelerating effect on growth of excised leaf in dark as well as light condition, but it does not promote growth in the intact undetached leaf, as far as our experiments are concerned. In the latter case the ineffectiveness of gibberellin on leaf growth seems to have some close relationship to the overgrowth of stem.

Gibberellin and kinetin seem to act in different manners on leaf growth. The former mainly acts on leaf area increase and the latter rather on fresh weight increase. Therefore, these two growth promoting substance seem to take part in leaf growth in different ways.

Summary

This study was made to ascertain whether gibberellin influences leaf growth or not, and to study its mode of action on leaf growth. The materials used were *Pisum sativum* and *Raphanus sativus*. The effect of gibberellin on growth of intact *Pisum* plant and excised *Pisum* internodes has been examined together.

Gibberellin is effective on leaf disk and excised internodes of *Pisum* floated on a medium containing gibberellin. But it has no effect on leaf growth of intact *Pisum* plant.

The optimum concentration of gibberellin for the promotion of leaf growth is 10 mg./l. and its effect appears on excised leaf within three hours after treatment.

Remarkable cell enlargement is observed in gibberellin treated leaves without any obvious increase in cell number.

Gibberellin promotes the leaf expansion rather than the increase of fresh weight in contrast with kinetin which accelerates the increase of fresh weight rather than that of leaf area. In the presence of both compounds, increase on leaf area and fresh weight is larger than when only one of the compounds is used. Therefore, gibberellin and kinetin seem to act in different manners on leaf growth.

When the intact *Pisum* was treated with gibberellin at lower stipule, the growth promoting effect of gibberellin moves to the upper internodes and petioles.

The authors wish to express their deep gratitude to Prof. M. Monsi and Ass. Prof. T. Yamaki of University of Tokyo and Prof. K. Hogetsu of Tokyo Metropolitan University who gave the authors helpful suggestions.

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Studies on Yeasts Isolated from Pine Honey II*

by Minoru YONEYAMA**

米山穰**: 松蜜から分離された酵母菌の研究 (第二報)*

Received November 5, 1956

In the previous paper¹⁾ the constant occurrence of *Torulopsis candida* in pine honey was reported. The author now found three yeast-strains occurring frequently in pine honey and the present paper will relate the results in detail. Experimental methods were almost the same as those mentioned in the preceding paper. An

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isolation method newly adopted was as follows: One sampling consisted of a series of five tubes in each of which a cotton ball of about 1 cm. in diameter (0.1 gram weight) soaked with malt broth was enclosed sterilized. In the field, each was put into a crack of one pine protuberance where pine honey was actually exuded. After ten minutes, each cotton ball which had been moistened with pine honey was directly put into the test tube above mentioned. They were brought back to the laboratory, and 10 ml of malt broth were poured into each of these test tubes and incubated at 25°C until 10 days. Then the white sediment was appeared on the bottom of the test tube, from which yeast was isolated applying the dilution method and Lindner's droplet culture method. Materials A and B were the same as those mentioned in the preceding paper. M, N, and P were newly employed materials. M was pine honey from a protuberance on the stem of *Pinus densiflora* in the Yana-se district, about 18 km north of Hiroshima City and Materials N, P were collected from two other stems of *Pinus thunbergii* in the same place.

Two attempts at isolation were made on Materials A and B, and three attempts on Materials M, N, and P during January through February, 1956.

Schizosaccharomyces versatilis Wickerham et Duprat, in J. Bact. 50: 597 (1945); Lodder and Kreger, The Yeasts, p. 89 (1952).³⁾
syn. *Schizosaccharomyces japonicus* Yukawa et Maki, in J. Kyushu Imp. Univ., Gakugei-Zasshi, 4: 218 (1931).⁴⁾

Frequency of occurrence of this yeast was as follows: twice from Material A, three times from Material P, and none from Materials B, M, and N. Some properties of this strain will be reported in other paper.⁵⁾ Only the optimum temperature for the growth of this strain is reported here. After various examinations, at 25°C, 30°C, 33°C, and 37°C, in malt extract and on malt agar, respectively, the optimum temperature for the growth of this strain was determined to be at 30°C. Yeasts belonging to the genus *Schizosaccharomyces* have been reported to grow best at high temperature,^{2,6,7,8)} ranging from 30°C to 37°C. The optimum temperature for the growth of the strain isolated here is the lowest of any yeast in this genus.

Saccharomyces cerevisiae Hansen var. *tetrasporus*(Beijerinck) Phaff *et al*, in Antonie Leeuwenhoek 22: 149 (1956).⁹⁾
syn. *Saccharomyces mangini* var. *tetrasporus*(Beijerinck) Dekker, in Stelling-Dekker, Die sporog. Hefen, p. 145 (1931).¹⁰⁾

Frequency of this yeast was as follows: Twice from Materials A and B, respectively; three times from Material M; once from Material N, and none from Material P.

This yeast resembles *Saccharomyces cerevisiae* Hansen in regards to its assimilation and fermentation, as well as its morphological characteristics, but it disagrees with the latter in the following features:

- (1) The small size of the cell;
- (2) The high percentage in sporulating cells;
- (3) Both the optimum and maximum temperatures for the sporulation of this strain are lower than those of *Sacch. cerevisiae* by about 5°C to 8°C;
- (4) Delay in maltose fermentation.

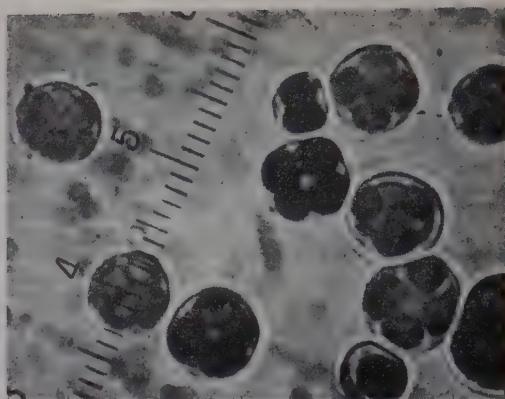


Fig. 1. *Saccharomyces cerevisiae* Hansen var. *tetrasporus*. Asci in each of which 2 or 4 ascospores are formed, on malt agar, after 10 days, at 20°C, stained by fuchsin. (one unit scale represents 1.0μ)

Saccharomyces sp. I.

This yeast was isolated three times from Material M and twice from Material P. Growth on malt agar: after 3 days at 25°C, cells are oval or long oval, measuring $(2-5) \times (4.5-8)\mu$, single, after 14 days at 25°C, several oil drops of various sizes in a cell, which were confirmed by staining of Sudan black; in the old-culture certain cells with one to three protuberances. Growth in malt extract: after 7 days at 25°C, sediment and a ring are distinctly, no pellicle. Streak culture on malt agar: after 14 days at 25°C, cream color, smooth, semi-glistening, fine lobated margin, after 25 days at 25°C, fuzzy growth appears along the margin. Giant colony on malt gelatin: after 45 days at 15°-20°C, round colony raised like a volcano, at the center of which one depression is formed, finely wrinkled surface, radially striated fringe and many fine transverse striations, lobulate and somewhat irregular margin, light-buff. Slide culture: pseudomycelium is formed on potato glucose agar under cover slip at the end of 3 days at 25°C. Sporulation: usually asci are easily formed on malt agar; ascospore globose, smooth in surface, measuring $3.5\mu-4\mu$ in dia-

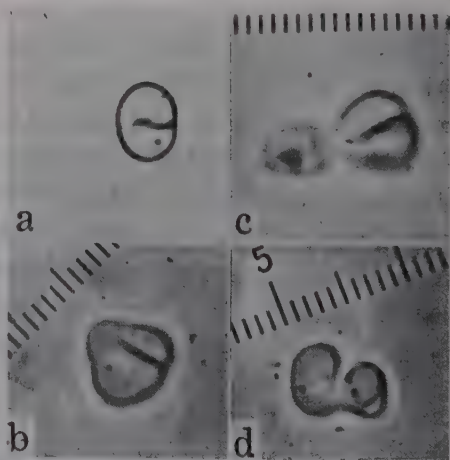


Fig. 2. *Saccharomyces cerevisiae* Hansen var. *tetrasporus*. Various stages in the conjugation of two ascospores in an ascus at the germination.

- a, conjugation of two spores,
 - b, germination,
 - c, a new vegetative cell has appeared,
 - d, side view of the conjugation.
- (one unit scale represents 1.0μ)

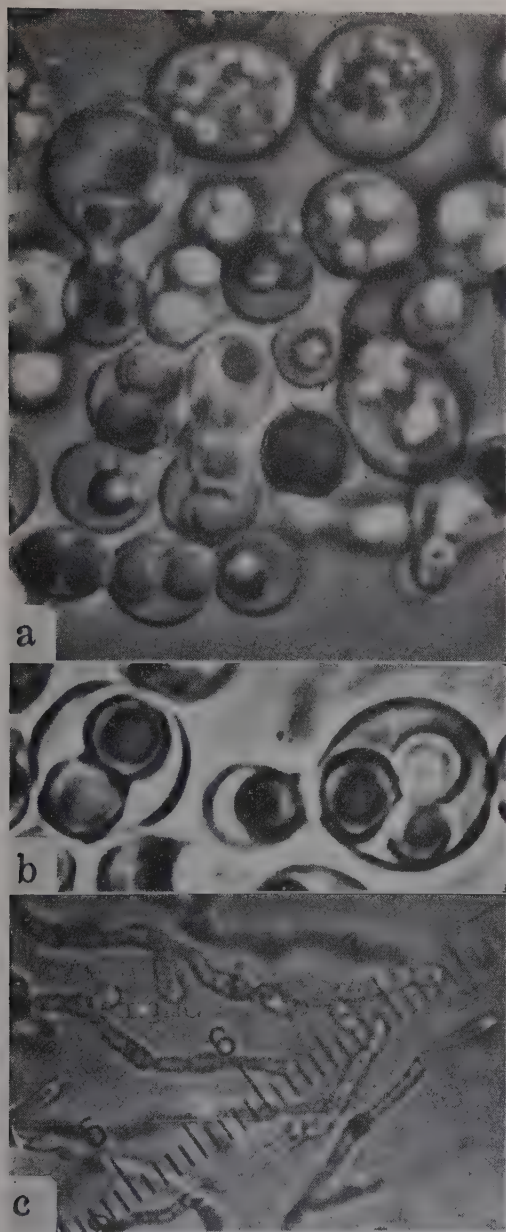


Fig. 3. *Saccharomyces* sp. I.

- a, Vegetative cells containing several oil drops of various sizes (in the upper part of the photo), and asci in each of which two spores containing large oil drops are found (in the lower part and near the center of the photo), on malt agar, 14 days, at 25°C. ($\times 1800$)
- b, Two asci; in this figure emphasis is placed on the showing of the large oil drop in an ascospore. ($\times 2500$)
- c, Pseudomycelium, on potato glucoase agar under cover slip, after 3 days, at 25°C. (one unit scale represents 2.5 μ)

meter, containing one large oil drop, this property is especially ascribed to the present yeast. Fermentation: glucose, saccharose, maltose, raffinose, and inulin are positive; galactose and lactose, negative. Sugar assimilation: glucose, galactose, saccharose, and maltose are positive but lactose, negative. Assimilation of potassium nitrate: absent (although one of isolates assimilated weakly).

There is no doubt that this yeast belongs to the genus *Saccharomyces* in morphological characteristics, as well as in behaviors towards sugar fermentation and assimilation. One of the noteworthy physiological characters of the present yeast is the ability to ferment inulin. There are only three species belonging to the genus *Saccharomyces*, having the ability to ferment inulin.³⁾ They are *S. fragilis*, *S. marxianus*, and *S. rosei*. The differences between the present strain and the above mentioned species are shown as follows:¹⁾

×	×	×	×
	×	×	×
		×	×
			×

	Ascospore	Pseudomycelium	Maltose fermentation
<i>S. fragilis</i>	kidney-shape	present	negative
<i>S. marxianus</i>	kidney-shape	present	negative
<i>S. rosei</i>	globose	absent	negative
the yeast questioned	globose, contains one large oil drop	present	positive

This yeast seems to be a new species, the full diagnosis of this yeast will be reported in the future.

Acknowledgment

The author desires to express his cordial gratitude and his hearty thanks to Dr. Shizuo Hattori, Dr. Kendo Saito, and Dr. Hirosuke Naganishi for their important suggestions and valuable advice.

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The Stigma Reaction II. The Presence of the Stigma Reaction in Intra-specific and Inter-generic Pollinations in the Gramineae*

by Kazuo KATO** and Kotaro WATANABE***

加藤一男・渡辺光太郎：柱頭反応 II. イネ科の種内及び属間受粉に於ける柱頭反応の存在

Received November 5, 1956

In *Secale cereale*, it has been found by one of the present authors (Kato, 1953) that in pollination, stigma cells to which a pollen grain attaches undergo a re-

* The first report was published by the senior author in Mem. Coll. Sci. Univ. Kyoto Ser. B, 20. 203-206 (1953).

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markable change in stainability very soon after pollination, and that this change can be demonstrated by staining with aceto-carmines or various dye solutions. The change is quickly followed by disintegration of the protoplasm and withering of the pollen attached cells. To all these changes of the stigma cells due to pollination, the term "stigma reaction" has been applied.

The present authors have been much interested whether this finding holds true or not for gramineous plants other than *Secale* and consequently this present investigation was undertaken.

Materials and Methods

As materials, various gramineous plants were used, most of which were easily obtainable in the neighbourhood of the Kyoto University. Some of these plants were kindly offered at our disposal by the Laboratory of Genetics. The stigma reaction was examined in pollinations of inter-generic as well as intra-specific combinations.

In pollination, several procedures were employed. In general a feathery stigma dissected from a floret was placed on a microscope slide and mature pollen grains freshly obtained were pollinated. The slide was kept in a Petri-dish with or without a sheet of wet filter paper. In some cases, pollination was made on ears or heads borne on plants which were placed in a vase in the room, and the pollinated stigmas were subsequently removed. The succeeding procedure was the same as above.

Artificial pollination is difficult in some grasses, such as *Digitaria ciliaris*, *Setaria viridis* and *Panicum Crusgalli* var. *submutica* etc. In these grasses, therefore, stigmas which had been pollinated naturally in the field were used for examination.

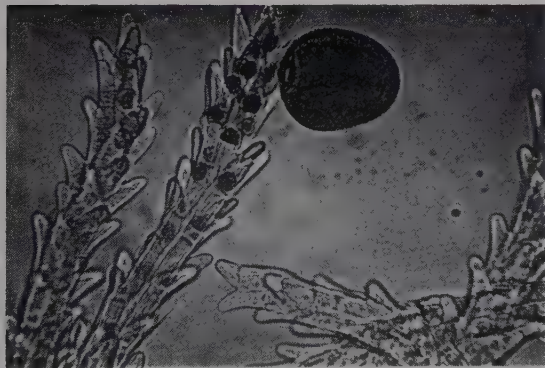


Fig. 1 a

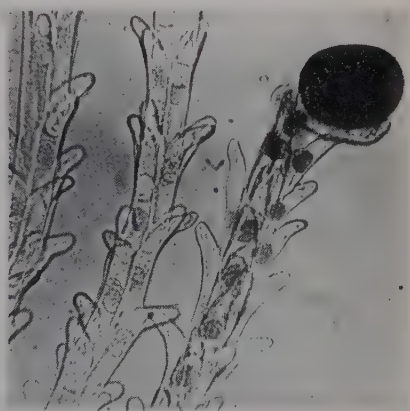


Fig. 1 b

Figs. 1a and b. Showing stigma reaction. a) *Secale cereale* \times *Avena fatua*. b) *Triticum Spelta* \times *Secale cereale*. In the stigma cells to which the pollen grain is attached, the nuclei are darkly stained. Further explanation in text. Aceto-carmines preparation. Magnification, ca. $\times 250$.

In most of the grasses used the stigma reaction can be demonstrated by employing aceto-carmin. When the pollinated stigma is treated with this solution, the stigma cells to which the pollen grain adheres are stained readily and distinctly and the stigma reaction can be ascertained. The non-pollinated cells, on the contrary, remain unstained for a considerable length of time, showing a clear contrast with those that are deeply stained. Photomicrographs of the stigma reaction are shown in Figs. 1*a* and *b* (see also, Figs. 1 and 2, Kato, 1953; where the stigma reaction in the intra-specific pollination is shown). The detection of the stigma reaction with aceto-carmin is indicated by a symbol AC in the following description. In some grasses this solution is not appropriate, especially in those whose stigma cells contain anthocyanin. In such cases, instead of aceto-carmin, aqueous solutions of methylene blue and methyl green were used with good results. The detection of stain reaction with methylene blue and methyl green are indicated by the symbols MB and MG respectively.

The longer the pollen grain is attached to the stigma, the greater is the stainability of the stigma cells (Kato, 1953). In the present investigation, the action time of pollen, that is, the interval between pollination and application of the dye solution was not fixed, since the aim of this investigation was merely to determine whether or not the stigma reaction is present.

Observations

a) Intra-specific pollinations. In the intra-specific pollination the grasses of 56 species, 36 in genus, were observed.

They are as follows:

Aegilops Aucheri (AC), *A. caudata* (AC, MB, MG), *A. ovata* (AC), *A. squarrosa* (AC), *Agropyron ciliare* (AC), *A. semicostatum** (AC, MG), *Alopecurus aequalis* (AC, MB, MG), *Arrhaxon hispidus* (AC), *Avena fatua* (AC), *A. sativa* (AC, MB, MG), *A. sterilis* (AC, MB), *Beckmannia erucaeformis* (MB, MG), *Briza minor* (AC, MB, MG), *Bromus unioloides* (AC), *Calamagrostis arundinacea* var. *sciuroides* (AC, MB, MG), *Coix Lachryma-Jobi* (AC, MB), *C. Ma-yuen* (AC, MB), *Dactylis glomerata* (AC), *Digitaria ciliaris** (AC), *Eleusine indica* (MB), *E. indica* var. *coracana* (AC, MB), *Eragrostis ferruginea* (AC)**, *Festuca parvigluma* (AC, MG), *Haynaldia villosa* (AC, MG), *Holcus Sorghum* var. *japonicus* (AC, MB, MG), *Hordeum spontaneo-nigrum* var. *turcomanicum* (MB), *H. spontaneum* var. *eu-spontaneum* (AC, MB), *H. vulgare* (AC), *Leptochloa chinensis* (AC, MG)**, *Lolium multiflorum* (AC, MB), *Melica nutans* (AC), *Microstegium vimineum* (AC, MB), *Miscanthus sinensis* (AC), *M. sacchariflorus* (AC), *Oplismenus undulatifolius* (AC), *Oryza sativa** (AC, MB, MG), *Panicum Crusgalli* var. *frumentaceum** (AC, MB), *P. Crusgalli* var. *submutica* (AC), *P. miliaceum** (AC), *Pennisetum japonicum* (MB), *P. typhoideum* (AC, MB), *Phalaris arundinacea* (AC, MB), *Poa acroleuca** (AC, MG), *P. annua* (AC, MB), *P. nipponica* (AC, MB), *P. pratensis** (AC, MB, MG), *Polypogon Hiegegaweri* (AC, MB), *Sasa nipponica* (AC), *Setaria italica** (AC), *S. lutes-*

* indicates those plants whose stigma reaction has been ascertained by both authors.

** means that stigma reaction is not distinct with methylene blue.

cens (AC), *S. viridis** (AC), *Trisetum bifidum* (AC, MB), *Triticale* sp. (AC, MG), *Triticum monococcum** (AC), *T. orientale* (AC, MB, MG), *T. Spelta* (AC, MB, MG), *T. vulgare* (AC, MB, MG) and *Zea Mays** (MB, MG).

In the above, the arrangement of genera and species is in alphabetical order. While there is certain advantage of this arrangement, closely related genera may be widely separated in the list. In all cases enumerated above, the stigma reaction can be demonstrated.

In the detection of the stigma reaction aceto-carminic has been tried in all cases. In a few grasses, however, the reaction can not be clearly detected with aceto-carminic until a pollen tube enters the stigmatic tissue. In order to obtain the stigma reaction other dye solutions may be used instead of the aceto-carminic with successful result. In such cases no symbol AC is noted in the brackets.

b) Inter-generic pollinations. To determine the stigma reaction in pollinations among different genera in the grasses, the following pollinations were studied.

Agropyron glaucum × *Avena fatua* (AC), *Agropyron glaucum* × *Triticum monococcum* (AC), *Agropyron semicostatum* × *Secale cereale* (AC), *Agropyron semicostatum* × *Phleum pratense* (AC), *Avena fatua* × *Secale cereale* (AC), *Avena sativa* × *Secale cereale* (AC), *Avena sativa* × *Triticum monococcum* (AC), *Briza minor* × *Avena sativa* (AC), *Hordeum spontaneum* var. *eu-spontaneum* × *Secale cereale* (MB), *Hordeum vulgare* × *Secale cereale* (AC), *Hordeum vulgare* × *Triticum vulgare* (AC), *Oryza sativa* × *Pennisetum japonicum* (MB), *Oryza sativa* × *Coix Lachryma-Jobi* (AC), *Oryza sativa* × *Phleum pratense* (AC), *Oryza sativa* × *Secale cereale* (MB), *Oryza sativa* × *Zea Mays* (MB), *Poa pratensis* × *Triticum vulgare* (AC), *Phalaris arundinacea* × *Agropyron semicostatum* (AC), *Phleum pratense* × *Agropyron semicostatum* (AC), *Secale cereale* × *Agropyron semicostatum* (AC), *Secale cereale* × *Alopecurus fulvus* (AC), *Secale cereale* × *Avena fatua* (AC), *Secale cereale* × *Avena sativa* (AC), *Secale cereale* × *Hordeum vulgare* (AC), *Secale cereale* × *Phalaris arundinacea* (AC), *Secale cereale* × *Triticum monococcum* (AC), *Secale cereale* × *Triticum Spelta* (AC), *Secale cereale* × *Triticum vulgare* (AC), *Secale cereale* × *Zoysia pungens* var. *japonica* (AC), *Setaria viridis* × *Phleum pratense* (AC, MG), *Setaria viridis* × *Secale cereale* (AC), *Triticum monococcum* × *Agropyron glaucum* (AC), *Triticum monococcum* × *Avena sativa* (AC), *Triticum monococcum* × *Secale cereale* (AC), *Triticum Spelta* × *Secale cereale* (AC), *Triticum vulgare* × *Hordeum vulgare* (AC), *Triticum vulgare* × *Secale cereale* (AC), *Zea Mays* × *Oryza sativa* (MB).

The inter-generic pollinations observed were 38 in all, 24 of which were reciprocal pollinations. In each of the reciprocals, the stigma reaction was clearly demonstrated with the test solutions, either AC or MB. The stigma reaction was also observed in the remaining 14 inter-generic pollinations.

The stigma reaction in the inter-generic pollinations are shown in photomicrographs in Figs. 1*a* and 1*b*. In Fig. 1*a* a single pollen grain of *Avena fatua* is attached to the stigma of *Secale cereale*. In the stigma cell, to which the grain attaches, and its neighbouring cells, the nuclei are stained while the other cells of this stigma remain unstained. The pollinated stigma is markedly contrasted to the non-pollinated ones with unstained nuclei. Fig. 1*b* shows the stigma reaction in the pollination *Triticum Spelta* × *Secale cereale*. In this figure a pollen grain of *Secale* is

attached to the stigma of *Triticum*. In the upper part of the stigma filament, to which the pollen grain is attached, the cell nuclei are deeply stained in three or more cells. The pollen tube is seen entering the stigmatic tissue. In the non-pollinated stigma filaments in the same figure the nuclei remain unstained.

Some remarks on the pollination between *Avena* and *Secale* will be mentioned. In the pollination *Avena fatua* × *Secale cereale*, pollen grains of the latter species may germinate on the stigma cells of the former, but many of the pollen grains burst before their pollen tube emerges. And if emerged they burst frequently at their end. On the other hand, in the case of the reciprocal pollination, *Secale cereale* × *Avena fatua*, many of *Avena* pollen grains shrink on the *Secale* stigma and are difficult to germinate. In both reciprocal pollinations, however, the stigma reaction is recognizable, in spite of the different behavior of pollen grains on stigma cells.

Discussion

As mentioned above, in all of 94 cases of different pollinations examined, including 56 intra-specific and 38 inter-generic pollinations, the stigma reaction can be recognized and no exceptional case is observed. In the inter-generic pollinations, there is no difficulty in obtaining the stigma reaction between any two species which are remotely related taxonomically. This finding is contrary to our expectation that there might be differences in stigma reaction, according to the taxonomic relationship within the Gramineae. As far as the present investigation goes, it is highly probable that this phenomenon of the stigma reaction occurs throughout the Gramineae, not only in self pollination of a species but also in any cross pollination within the family. It may be noteworthy that the stigma reaction occurs only occasionally when gramineous stigma is pollinated by pollen of other monocotyledonous families. In some dicotyledonous plants the stigma reaction can also be proved to be present, if intra-specific pollination is made. These observations will be reported later.

Stigma reaction may be of some practical importance. Under certain circumstances where several species of cereals are cultivated closely in the field, stigmas of one species are apt to be pollinated, not only by its own pollen but also by foreign pollen. Consequently, in some stigma cells the stigma reaction takes place due to the foreign pollen grains, since this reaction is common in all grasses and it is always positive in any cross pollination. In such cases if the stigmas of a species are withered by attachment of foreign pollen grains, self pollination may be hindered, and fertility of the grass would be decreased.

Summary

1) The stigma reaction is a change which is taken place in the stigma cells, following the attachment of pollen grains to them. The reaction can be demon-

strated with aceto-carmin and other dye solutions, by showing that the stigma cell with a pollen grain is more easily stained than those cells without a pollen grain.

2) The stigma reaction is widely recognizable among gramineous plants. In the present investigation, 94 cases of pollination, 56 intra-specific and 38 inter-generic pollinations, have been examined. In all these cases the stigma reaction has been ascertained.

Accordingly, it may be believed that the stigma reaction is a general phenomenon taking place in any pollination in gramineous plants, whether it is intra-specific or inter-generic.

3) A brief discussion on the possible practical importance of stigma reaction is presented.

We take this opportunity of thanking Prof. N. Shinke, Botanical Institute, and Prof. S. Imamura, Laboratory of Applied Botany in Kyoto University, for their interest and criticism throughout the investigation.

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Electron-microscopical Study on Fine Structures of Diatom Frustules XV.

Observation on the genus *Rhizosolenia*¹⁾

by Haruo OKUNO*

奥野春雄*: 電子顕微鏡による珪藻殻微細構造の研究 XV. リゾソレニア属についての観察

Received November 5, 1956

Rhizosolenia acuminata (Peragallo) Gran (Pl. I, Figs. 1a-c), Hustedt, Kieselalg. 1: 605, fig. 350 (1930); Mills, Index Diat. 1399 (1934); Gaarder, Bacill. Rep. Michael Sars, 2: 22, Fig. 8 (1951); Proschkina-Lavrenko, Diat. Black Sea, 94 (1955).

L.M.S.²⁾ (Fig. a) Cells with fairly drawn out, obliquely conical calyptrae, about 700-950 μ long and about 70-150 μ in diameter. Seta short, about 20-50 μ long. Wings at the base of seta distinct. Calyptra with distinct mark for seta and wings of the

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1) Hitherto, the following species of this genus were researched with the electron microscope: *Rh. alata* (Okuno, 1952), *f. indica* (Desikachary, 1954), and *f. inermis* (Okuno, 1952); *Rh. bidens* (Okuno, 1952); *Rh. hebetata f. semispina* (Okuno, 1952, 1954); *Rh. imbricata* var. *Shrubsolei* (Desikachary, 1954. Probably misidentification of *Rh. styliiformis* or its variety); *Rh. styliiformis* (Helmcke & Krieger, 1953), var. *latissima* (Okuno, 1952), and var. *longispina* (Okuno, 1952); *Rh. Temperei* (Okuno, 1952).

2) L. M. S.: Light-microscopic structure.

adjacent cell. Intercalary bands rhomboidal, arranged in longitudinal and two oblique rows about 3 in 100μ . Hustedt suggested that this species may be a slender form of *Rh. Temperei*. In my specimens, the large cells about 170μ long were provided with lower conical calyptra as those of *Rh. Temperei*.

E.M.S.³⁾ (Figs. b, c) Materials were observed by their direct preparations. The general fine structure of the loculi in this species is much the same as in *Rh. Temperei* (cf. Okuno, Bot. Mag. Tokyo, **65**: 162, pl. 2, figs. 3-3'''. 1952). Loculi on the calyptra usually rectangular or subrectangular, arranged in longitudinal rows about 21-24 in 10μ , radiating downwards from the apex. Sieve membrane of the loculus probably on the outside, and usually has 3-4 short slit-like sieve pores about 70-130 μ long and about 40-60 μ broad. In small loculi, the number of sieve pores sometimes reduced to one. In a loculus sieve pores usually arranged in a transverse row, but rarely in row of other various directions. The cover membrane is probably on the inside, leaving a large subrectangular opening in the center. Loculi on the intercalary band rectangular, about 500-600 μ square, rarely irregularly hexagonal, arranged in longitudinal and two indistinct oblique rows about 15-18 in 10μ . Sieve membrane (*sm*) probably on the outside, and has about 4-6 (usually 4) slit-like sieve pores (*sp*) about 70-130 μ long and about 40-60 μ broad. Sieve pores arranged in a transverse row in the middle of the sieve membrane. Along the borders of intercalary bands, the shape of loculi and the direction of the rows of sieve pores often irregular. In addition to the sieve pores, very minute pores or poroids are occasionally scattered on the sieve membranes. Cover membrane (*cm*) of the loculus well developed, leaving a round opening (*oc*) 250-450 μ diameter in the center. In the loculus, beside the sieve and cover membranes, a very thin, funnel-shaped diaphragm (?) with a small round opening (*od*) is often found, but its details could not be discerned in the present research. In my present specimens, the rhomboidal intercalary bands, on their two sides remoter from the calyptra, have fine connective teeth (*t*) about 5-7 in 1μ , and at the conjunction of calyptra and the adjacent intercalary band, the teeth are found on the side of the intercalary bands.

Habitat: Marine plankton. Japan Sea (36-36.4N; 134-32.2E. 36-20.7N; 134-53.0E) (Okuno, Nos. m450, 452. Jul. 1950. Collected by H. Maeda). Oki Island, Shimane Prefecture (Okuno, No. m1030. Oct. 1955).

Rhizosolenia hebetata (Bailey) Gran f. **hiemalis** Gran (Pl. I, Figs. 2a, b), Peragallo, Diatomiste, **1**, pl. 18, fig. 10 (1892); Akatsuka, Plank. Diat. Takashima, **37**, pl. 7, fig. 4 (1914); Mills, Index Diat. 1405 (1934); Cleve-Euler, K.V.A. Handl. **2**, no. 1: 89, fig. 170a (1951).

L.M.S. (Fig. a) Cells about 25-33 μ in diameter and up to 500 μ long. Calyptra drawn out. Seta short, thickened, obtuse at the end, with a distinct hollow at the base. Intercalary bands rhomboidal, arranged in two alternating dorsiventral rows.

3) E. M. S.: Electron-microscopic structure.

E.M.S. (Fig. b) Materials were observed by their direct preparations. Loculi on the intercalary bands are arranged in three lines decussating at about 60 degrees, about 23-27 in 10μ . Loculus hexagonal, with a sieve membrane probably on the outside, and a cover membrane probably on the inside. The sieve membrane has a longitudinal slit-like sieve pore about $30m\mu$ broad. Cover membrane well developed, with a round opening about $200m\mu$ in diameter. In the present research, the lateral membrane of the loculus could not be revealed. The loculus of *Rh. hebetata* f. *semispina* (Text Fig. 1A; Pl. I, Figs. 3a, b) is much the same in shape and structure as that of the present form, differing only in having two longitudinal sieve pores (cf. Okuno, Journ. Jap. Bot. 29: 18, pl. 1, fig. 1, pl. 2, figs. 1, 1'. 1954). Such an electron-microscopical dimorphism of the sieve membrane of *Rh. hebetata*, in which the one has a sieve pore (f. *hiemalis*) and the other two sieve pores (f. *semispina*), recalls the light-microscopic dimorphism of the present species reported by Meunier (1910, p. 254), Akatsuka (1914, p. 37), Hustedt (1930, p. 129), Cupp (1943, p. 88, 89), and Cleve-Euler (1951, p. 90). By these investigators, such an interesting intermediate form between f. *hiemalis* and f. *semispina* was reported, which on one end had a short seta of f. *hiemalis*, and on the other end a long, slender seta of f. *semispina*. And Meunier named such an intermediate form as *Rh. hebetata* f. *heterothrix*. Akatsuka reported that such intermediate cells were found frequently from November to April at Takashima, Hokkaido. Hustedt commented as follows: "Gran fand Teilungsstadien von *Rh. hebetata*, die als Tochterzellen von *Rh. semispina* ergaben, und aus der geographischen Verbreitung beider Formen kann man darauf schliessen, dass ein Dimorphismus vorliegt, in dem *Rh. hebetata* die Winterform oder Ruheperiode der *Rh. semispina* darstellt." In my samples from the Bering Sea (Jul. 1955) and Northern Pacific Ocean (Jun.-Jul. 1952), I found both f. *hiemalis* and f. *semispina*, but no f. *heterothrix*, and I found many cells of f. *semispina* in my samples from the Antarctic Ocean (Nov.-Dec. 1951. Jan.-Feb. 1952). Thus f. *semispina* showed a bipolar occurrence. In f. *semispina*, teeth (*t*) of the intercalary bands were distinctly observed. Further, judging from the electron micrographs of loculi of f. *semispina* photoed at various angles, the sieve membrane is distinctly on the outside and the cover membrane is on the inside of the loculus⁴, and each side of the lateral membrane is perforated by a large subrectangular lateral pore by which the neighbouring loculi can communicate with each other as in *Coscinodiscus concinnus* (cf. Okuno, Bot. Mag. Tokyo, 68: 125, Text fig. 2A. 1955). Details of the structure of the loculi of f. *semispina* are shown diagrammatically in Text fig. 1A. In my researches on *Rh. alata* f. *inermis*⁵, *Rh. bidens*⁶, *Rh. styliformis* var. *longispina*⁷, and *Rh. Tem-*

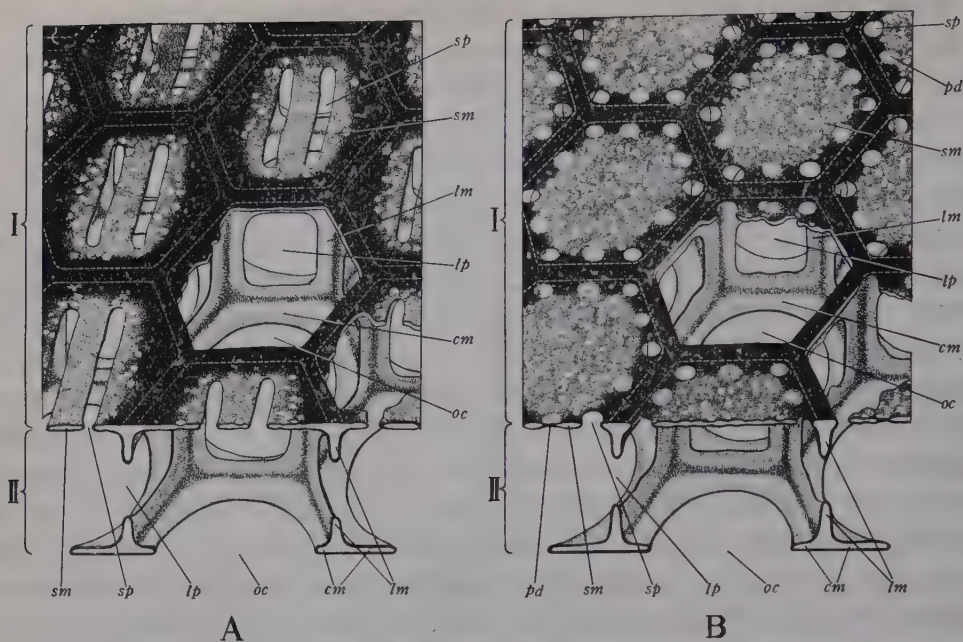
4) Cf. Okuno, Journ. Jap. Bot. 29: 18, Pl. 1, Fig. 1, Pl. 2, Figs. 1, 1' (1954).

5) Okuno, l. c. 27: 354, Text Fig. 1A; Pl. 2, Fig. 6' (1952).

6) ———, l. c. 27: 352, Text Fig. 1B; Pl. 2, Figs. 3'-3'' (1952).

7) ———, l. c. 27: 47, Pl. 1, Fig. 1'; 27: 351, Text Fig. 1D, Pl. 2, figs. 1'-1'' (1952).

8) ———, l. c. 27: 47, Text Fig. 1A, Pl. 1, Fig. 2 (1952).



Text Fig. 1. Diagrams of fine structure of loculi on intercalary band. A. *Rhizosolenia hebetata* f. *semispina* (cf. Pl. I, Fig. 3b). B. *Rh. styliformis* var. *latissima* (cf. Pl. II, Figs. 2b-d). I, Viewed from obliquely above. II, Idealistic longitudinal section. *cm*, Cover membrane. *lm*, Lateral membrane. *lp*, Lateral pore. *oc*, Opening of cover membrane. *pd*, Poroid. *sm*, sieve membrane. *sp*, Sieve pore.

*perei*³⁾, the sieve membranes were found on the outside of the loculus and the cover membranes on the inside. Whereas, Desikachary reported that in *Rh. imbricata* var. *Shrubsolei* and *Rh. alata* f. *indica*, the sieve membrane is on the inside and the cover membrane on the outside (Desikachary, Mikrosk. 9: 170, 172. 1954), although in his description, unfortunately, I could not find the reason for his opinion.

Habitat: Marine plankton. f. *hiemalis*. Northern Pacific Ocean (50-30N; 175-47E. 49-30N; 164-4E. 50-00N; 179-37E) and Bering Sea (53-02N; 172-00E. 53-50N; 178-52W). (Okuno, Nos. m710, 726, 807—Northern Pacific. Jun.-Jul. 1952. Collected by H. Maeda. Nos. m 1040, 1055—Bering. Jul. 1955. Collected by S. Motoda.)

f. *semispina*. Bering Sea (52-15N; 161-09W). (Okuno, No. m1065. Jul. 1955. Collected by S. Motoda.)

***Rhizosolenia imbricata* Brightwell var. *Shrubsolei* (Cleve) Schröder** (Pl. I, Figs. 4a, b), Hustedt, Kieselalg. 1: 584, fig. 332 (1930); Mills, Index Diat. 1405 (1934); Desikachary, Mikrosk. 9: 174, fig. 19 (1954).

L.M.S. (Fig. a) Cells about 8-20 μ in diameter, and about 250-600 μ long. Calyptra obliquely pointed. The seta with small wings at the base. Calyptra with distinct impression of the seta and wings of the adjacent cell. Intercalary bands subrhomboid, arranged in two perivalvar rows. Intercalary bands with rows of parallelogramatic loculi running fan-like from the longitudinal axis toward the side, about 12-18 in 10 μ .

E.M.S. (Fig. b) Materials were observed by their direct and formal preparations. Loculi on intercalary bands show very characteristic shape and structure. They are parallelogramatic, about 400–900 μ long and about 300–450 μ broad; at the border of the bands, often much smaller. Loculi have a sieve membrane probably on the outside, and a rudimentary cover membrane probably on the inside. The sieve membrane is very thin, with a slit-like diagonal sieve pore. Sieve pores about 40–50 μ broad, usually parallel in a row of loculi. Cover membrane of the loculus rudimentary, marginal, leaving a large, subparallelogramatic opening. Details of the lateral membranes of the loculi could not be revealed. Desikachary published five electron micrographs under the name of the present variety (Desikachary, Mikrosk. 9: 171, figs. 5–9. 1954). But his micrographs show loculi of quite different structure as compared with those of my present micrographs. His micrographs show loculi rather similar to those of *Rh. styliformis* var. *longispina* (cf. Okuno, Journ. Jap. Bot. 27: 351, Text fig. 1D, pl. 2, figs. 1–1". 1952). Further, in his description no basis was shown by which he identified his specimens as *Rh. imbricata* var. *Shrubsolei*. Thus I regard his figs. 5–9 are not of the present variety, but of *Rh. styliformis* or its variety. On the other hand, his micrograph in fig. 19, which he described as of *Rh. sp.*, is not at all clear, but shows the same parallelogramatic loculi and the diagonal sieve pores as of the present variety. And I regard his fig. 19 as probably representing *Rh. imbricata* or its var. *Shrubsolei*.

Habitat: Marine plankton. Kariya and Sano, Awaji Island, Hyôgo Prefecture (Okuno, Nos. m863, 865, 989. Aug. 1953, 1954). East China Sea (32–50N; 123–15E. 32–54N; 124–12E) (Okuno, Nos. m930, 932. Sep. 1953. Collected by H. Maeda).

Rhizosolenia robusta Norman (Pl. II, Figs. 1a–c), Castracane, Rep. Challenger, Bot. 2: 73, pl. 24, fig. 5 (1886); Mills, Index Diat. 1408 (1934); Cupp, Bull. Scripps Inst. Ocean. 5: 83, fig. 46 (1942).

L.M.S. (Fig. a) Cells very large, about 200–250 μ in diameter and up to 1mm long. Usually living singly. Calyptra asymmetrically conical and curved at the end. Seta very short. Intercalary bands collar-shaped, parallel.

E.M.S. (Figs. b, c) Materials were observed by their direct preparations. Frustule pores both on calyptrae and intercalary bands are locular. Loculi usually hexagonal. On calyptrae, the loculi arranged in longitudinal and two indistinct oblique rows. Longitudinal rows about 22–24 in 10 μ , in each row loculi about 14–17 in 10 μ . On intercalary bands, loculi arranged in three lines decussating at about 60 degrees. The longitudinal lines about 20–28 in 10 μ , in each line loculi about 20–26 in 10 μ . Loculi usually hexagonal with normal size, but in my specimens their walls are remarkably thicker than in the other species of the same genus, and the dimension of the cavity of loculus is exceedingly reduced. Sieve membrane is probably on the outside of the loculus, with a linear sieve pore about 200–400 μ long (rarely reduced to 100 μ) and about 30–50 μ broad. Sieve pores usually lie in longitudinal direction both on calyptrae and on intercalary bands, but very rarely

in other directions. Lateral pores of the loculus probably absent. Opening of the cover membrane rounded, about $230-400\mu$ in diameter. Borders of the intercalary bands have delicate teeth (*t*).

Habitat: Marine plankton. Nishimaizuru, Kyoto Prefecture (Okuno, No. m397. Feb. 1950. Collected by H. Maeda). Kariya, Awaji Island, Hyôgo Prefecture (Okuno, No. m863. Aug. 1953). $39-00N$; $153-00E$. (Okuno, No. m977. Nov. 1952. Collected by R. Marumo).

Rhizosolenia styliformis Brightwell var. **latissima** Brightwell (Text Fig. 1B; Pl. II, Figs. 2a-d), Hustedt, Kieselalg. 1: 586, fig. 335 (1930); Mills, Index Diat. 1410 (1934); Okuno, Journ. Jap. Bot. 27: 352, Pl. 2, Figs. 2-2''' (1952).

L.M.S. (Fig. a) In my specimens, cells about $130-200\mu$ in diameter and about 700μ long. Calyptra obliquely pointed, lower than in the type. Seta short, about $20-25\mu$ long, with two wings at the base. Valve with distinct impression of both seta and wings of the adjacent valve. Intercalary bands scale-like, arranged in dorsal-ventral rows, narrower and more numerous than in the type, about 6-8 in 100μ . Loculi on calyptra arranged in longitudinal rows about 15-18 in 10μ , in each row about 17-25 in 10μ . Loculi on intercalary bands arranged in three lines decussating about 60 degrees; about 10-20 in 10μ .

E.M.S. (Text Fig. 1B; Figs. b-d) I have already reported some of the fine structure of the loculi of the present variety from the Antarctic Ocean (Okuno, Journ. Jap. Bot. 27: 352, pl. 2, figs. 2-2'''. 1952). Here I will describe the similar and more or less modified fine structure of the loculi of the same variety collected from the East China Sea, Tsushima Strait, and Tanabe Bay. In the present specimens, the loculi on the calyptra usually rectangular (Fig. b), rarely rounded, each with a sieve membrane probably on outside and a cover membrane probably on inside. Sieve membrane has about 2-4 round sieve pores about $50-60m\mu$ in diameter on the corners or on the margin, but they are fairly variable in position and in number. Cover membrane somewhat broad, with a large subrectangular opening. Loculi on the intercalary bands usually hexagonal, each with a sieve membrane (*sm*) probably on the outside and a cover membrane (*cm*) probably on the inside. Sieve membrane with six round sieve pores (*sp*) about $50-80m\mu$ in diameter on the corners, and alternating often with six poroids (*pd*) on each side, which are of the same shape and size as the true sieve pores. In some specimens from the East China Sea, the sieve membranes densely scattered with fine dot-like pores beside the sieve pores and poroids. Lateral membrane (*lm*) about $50-70m\mu$ thick, with a large subrectangular lateral pore (*lp*) on each side. Cover membrane marginal, with a large round opening (*oc*) about $400-500m\mu$ in diameter. Teeth on the border of intercalary bands distinct, about $400-500m\mu$ long, and about 6-7 in 1μ . At the conjunction of calyptra and the adjacent intercalary band, teeth were found on the side of intercalary band and attached to the inside of the calyptra. Desikachary published five electron micrographs under the name of *Rh. imbricata* var. *Shrubsolei* in Mikrosk. 9: 170,

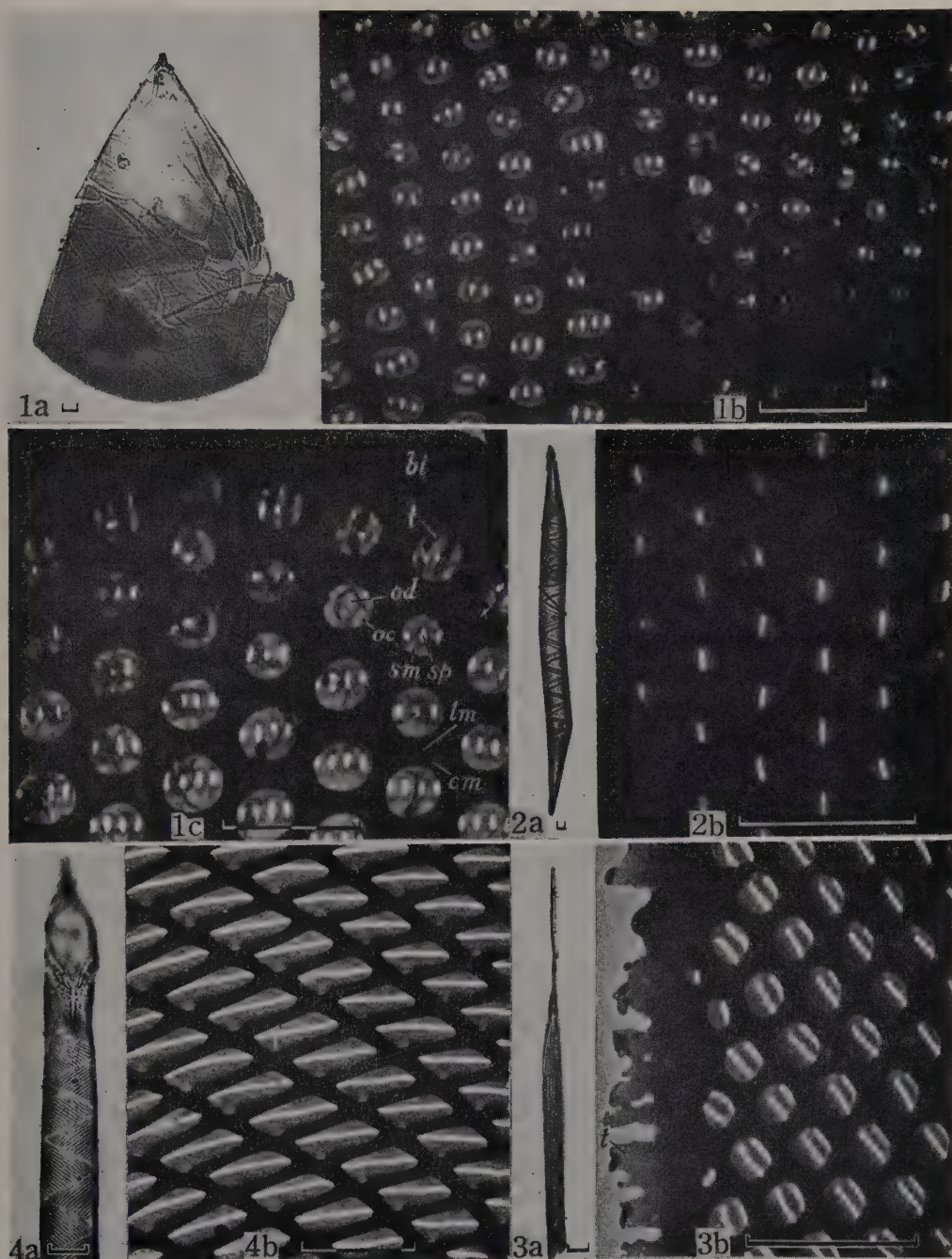


Plate I. Figs. 1a-c, *Rhizosolenia acuminata*. a, End part of cell. b, Portion of calyptra. c, Portion of intercalary band. 2 a, b, *Rh. hebetata* f. *hiemalis*. a, Girdle view of cell. b, Portion of intercalary band. 3a, b, f. *semispina*. a, Part of cell. b, Portion of intercalary band (cf. Text Fig. 1A). 4a, b, *Rh. imbricata* var. *Shrubsolei*. a, End part of cell. b, Portion of intercalary band. *bi*, Border of intercalary band. *cm*, Cover membrane. *lm*, Lateral membrane. *oc*, Opening of cover membrane. *od*, Opening of diaphragm. *sm*, Sieve membrane. *sp*, Sieve pore. *t*, Tooth. (a, Light micrograph. Scale: 10 μ . b, c, Electron micrograph. Scale: 1 μ .)

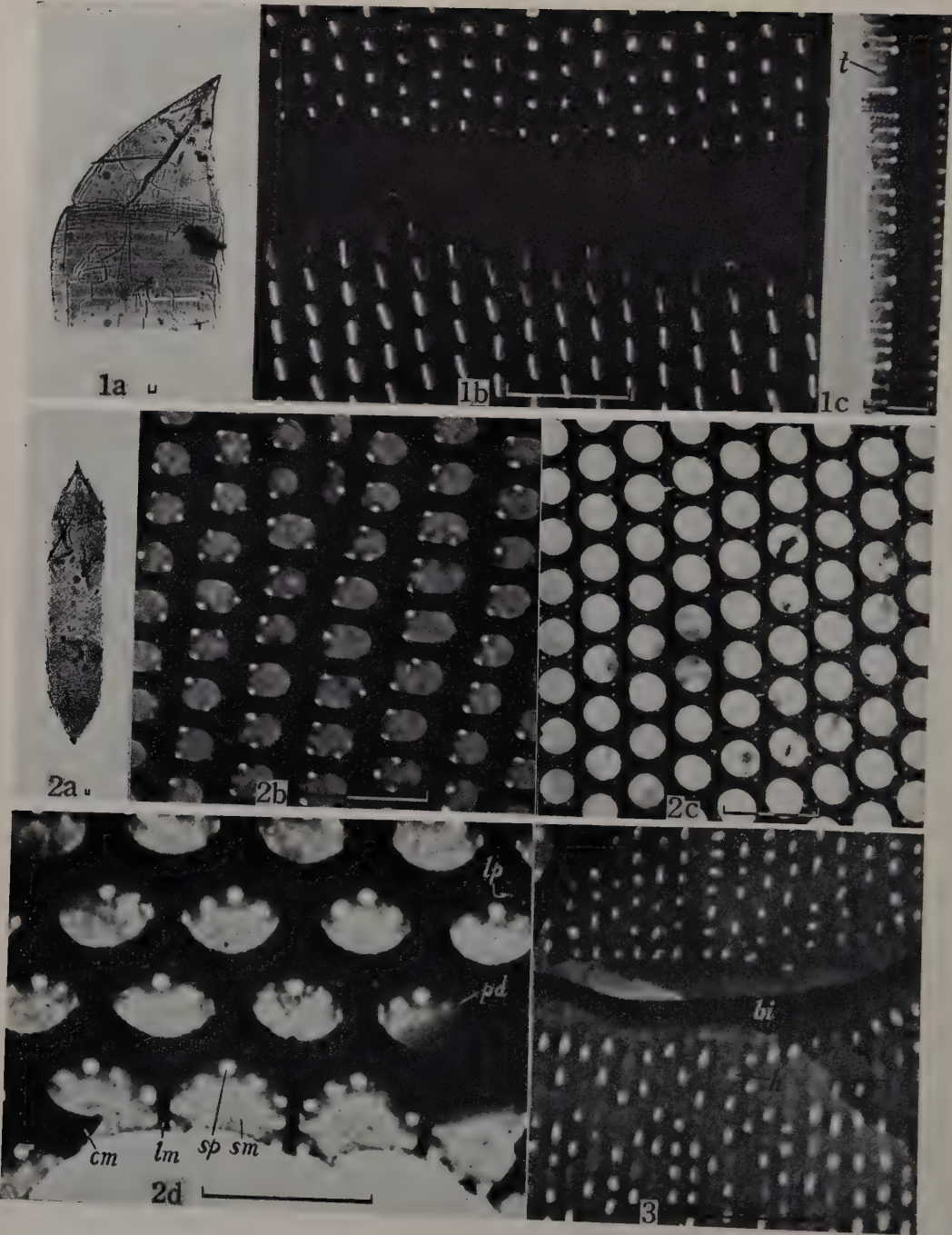


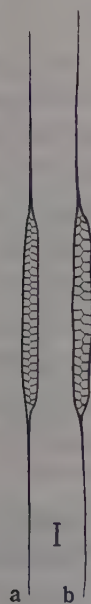
Plate II. Figs. 1a-c, *Rhizosolenia robusta*. a, End part of cell. b, Portion of intercalary bands. c, Border of intercalary band, showing teeth. 2a-d, *Rh. styliformis* var. *latissima*. a, Girdle view of cell. b, Portion of calyptra. c, Portion of intercalary band; sieve membranes could not developed in printing. d, Loculi of intercalary band, viewed from obliquely above (cf. Text Fig. 1B). 3, *Rh. longiseta*; portion of intercalary bands. h, Hole. lp, Lateral pore. pd, Poroid. (a, Light micrograph. Scale: 10 μ . b-d, Electron micrograph. Scale: 1 μ .)

H. Okuno: Fine structure of diatom frustules

figs. 5-9 (1954), which show the loculi as of the same structure as the present variety. On the other hand, according to my research, the structure of the *Rh. imbricata* var. *Shrubsolei* shows quite a different structure as described in the present paper (Pl. I, Fig. 4b). And judging from the strongly drawn-out calyptra and the structure of loculi, I regard Desikachary's Figs. 5-9 as being of *Rh. styliformis* or its var. *longispina*. Helmcke and Krieger published some electron micrographs of *Rh. styliformis* in their Diat. Elektr. Bild, **1**, pl. 30 (1953) but unfortunately I have not yet been able to see them.

Habitat: Marine plankton. Tanabe Bay, Wakayama Prefecture (Okuno, No. m569. Nov. 1950). East China Sea (32-54N; 124-12E.) (Okuno, No. m932. Sep. 1950. Collected by H. Maeda). Tsushima Strait. (Okuno, No. m1000. Jun. 1955. Collected by H. Maeda).

Rhizosolenia longiseta Zacharias (Text Fig. 2; Pl. II, Figs. 3), Hustedt, Süsw. Diat. **31**, pl. 1, fig. 1 (1914); Mills, Index Diat. 1406 (1934); Cleve-Euler, K.V.A. Handl. **2**, no. 1:90, fig. 172 (1951).



Text. Fig. 2.
Rhizosolenia longiseta. Linear (a) and
swollen (b) cells.
(Scale: 10μ .)

L.M.S. (Text Fig. 2) Cells usually solitary. Frustules cylindrical, in my specimens often slightly swollen in the middle (Fig. 2b). Cleve named such a swollen form as var. *Levanderi* (1915). Length about $100-210\mu$; diameter about $6-13\mu$. Calyptra elongated, with a long seta about $100-130\mu$ long. Intercalary bands half-collar-shaped, about 2-3 in 10μ .

E.M.S. (Fig. 3) Materials were observed by their direct preparations. Frustules thin, perforated by subrectangular holes (*h*) about $50-100m\mu$ long and about $30-50m\mu$ broad. Holes arranged in dense longitudinal rows about 60-65 in 10μ , in each row holes about 40-50 in 10μ . Borders of the intercalary bands (*bi*) thickened, probably without teeth. Marine *Rhizosolenia* species hitherto researched showed, without exception, more or less complex loculi. And the present fresh water form was the only species which showed non-locular frustule pores, the holes. Wall of the seta perforated at its base by dense holes a little smaller than those on intercalary bands. At the distal part of the seta, I could not see sure evidence of the holes, though there were indications of their presence.

Habitat: Fresh water plankton. Biwa Lake, Shiga Prefecture (Okuno, No. 1556. Jun. 1950).

Acknowledgements

I wish to express my hearty thanks to Dr. S. Motoda, Dr. R. Marumo, and Mr. H. Maeda, who kindly sent samples of plankton diatoms from various localities for my use.

On the Types of the Marginal Growth in Dicotyledonous Foliage Leaves*

by Noboru HARA**

原 襄**： 双子葉植物の普通葉における葉縁生長の型について*

Received December 15, 1956

Reports concerning the marginal growth of dicotyledonous leaves were reviewed thoroughly by Foster (1949) and Esau (1953). According to Foster (1936, cf. Foster, 1937), the results obtained by the previous investigators indicate a general agreement in one important point—viz., the outermost layer of cells at the leaf margin represents an independent histogen which corresponds in its growth and anticlinal plane of cell division to “dermatogen” and marginal initials give rise solely to the epidermis. In subsequent reports (e.g. Girolami, 1954) this fact is also invariable so far as it concerns the ordinary leaves of dicotyledons. Inside marginal initials of these leaves submarginal ones are generally observed, and their types were discussed by many workers. Foster (1936, cf. Esau, 1953) showed two types, that is, in the first type, submarginal initials contribute to the formation of the adaxial, middle, and abaxial layers, and the middle one further gives rise to the middle mesophyll and the procambium, while in the second type, they form only the adaxial and abaxial layers, and the latter one gives rise to the middle layer which further differentiates into the middle mesophyll and the procambium. Gifford (1951) found a different type***, on the basis of *Drimys Winteri* var. *chilensis*, in which submarginal initials produce at first the adaxial and abaxial layers, and the adaxial layer gives rise to the middle layer which further differentiates into the middle mesophyll and the procambium. On the other hand, Schneider (1952) recognized two types, that is, PA- and ZS-Types. In the former, submarginal initials divide in periclinal and anticlinal planes, while in the latter, they divide only in oblique plane.

In these reports concerning the marginal growth in dicotyledonous leaves, exceptions were observed by Renner (1936) and Renner and Voss (1942, cf. Esau, 1953) in certain variegated leaves such as those of *Sambucus nigra*, *Veronica gentianoides* and *Pelargonium zonale*. In these cases periclinal divisions in the protoderm may produce white margins, but no such evidence is observed in normal green leaves in these species. In variegated leaves of *Daphne odora* and *Fragaria chiloensis* this fact has been also suggested by Imai (1936), though he submitted no such histogenetic evidence as Renner's observation. Although Foster (1937) reported in bud scales of certain

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*** In monocotyledons, the same type was observed in maize leaf by Mericle (1950).

species of *Rhododendron* that marginal initials divide in oblique and periclinal planes, the process of development of the scale leaf is not always the same with that of the foliage leaf (cf. Cross, 1938). Thus, if our attention is restricted to the marginal growth of the dicotyledonous foliage leaf, exceptions are represented only by certain variegated leaves mentioned above.

Recently, the writer had an opportunity to observe the ordinary foliage leaf of *Daphne odora* of the Thymelaeaceae and found that the marginal growth in this leaf shows an exceptional type resembling certain variegated leaves in dicotyledons. Moreover, during the writer's studies on the structure of the shoot apex and the development of the leaf in the Ericaceae and its allies, he found that the marginal growth of the leaf of *Tripetaleia paniculata* shows the similar type to that of *Drimys Winteri*. These will be reported in this paper, and the developmental process of the marginal growth of a few other species in the Ericales will also be reported for the sake of comparison in discussing the standard types of the marginal growth of the dicotyledonous foliage leaves.

Materials and Methods

The leaves of *Daphne odora* Thunberg were obtained at the University of Tokyo, and those of *Tripetaleia paniculata* Sieb. et Zucc., *Pieris japonica* D. Don, and *Clethra barbinervis* Sieb. et Zucc. were obtained mainly in the Nikko Branch, Botanic Gardens of the University of Tokyo.

Materials were fixed in FAA, dehydrated in normal butyl alcohol, cut at 10μ , and counterstained with haematoxylin and fast green.

In all cases median cross sections of leaves in various developmental stages were observed for comparison.

Observations

Daphne odora. As is shown in Fig. 1, the primordium of the leaf initiates from the shoot apex following the ordinary process of the dicotyledonous leaf. Before the marginal growth initiates, the protoderm surrounding the primordium undergoes here and there frequent periclinal divisions, which are not the ordinary feature of the dicotyledonous leaf. The initiation of the marginal growth is recognizable by protruding of marginal stripes on both sides of the adaxial part of the primordium. As soon as the marginal growth initiates, marginal initials re-

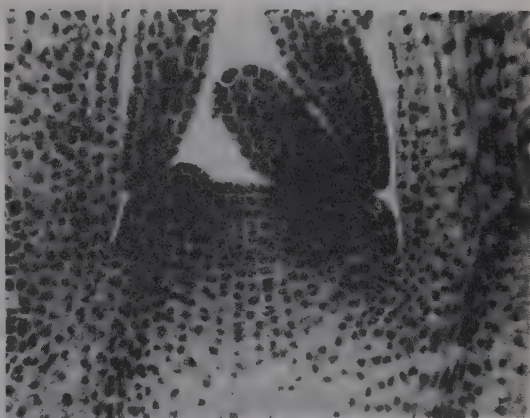


Fig. 1. Longitudinal section of a shoot apex of *Daphne odora*, with leaf primordia ($\times 150$).

peatedly divide in anticlinal plane to the leaf margin and give rise to the upper and lower protoderms (Pl. III. A), the growth in surface of the protoderm being accomplished by the further anticlinal divisions and cell enlargement of their derivatives. The marginal initials, however, also divide very frequently in oblique plane, forming the biseriate margin (Pl. III. B, F), and cells on the biseriate margin divide in periclinal plane to the leaf surface, forming inner layers of the leaf. Moreover, it is interesting enough that we can observe occasional periclinal divisions to the leaf margin in cells of marginal initials (Fig. 2. A, Pl. III. C, G), and even periclinal ones to the leaf surface in protodermal cells closed to marginal initials (Pl. III. D, H). So that, no stable submarginal initials are recognizable in this instance. In developing lamina, one or a few isolated mesophyll cells are often found in the biseriate margin (Pl. III. E). These cells arise obviously from marginal initials or their derivatives.

Thus, the growth in inner layers as well as upper and lower protoderms is accomplished by the activity of marginal initials over the greater part of the leaf, excepting the median part of the leaf, which is considered to arise from the second cell layer of the shoot apex. The mature leaf has an uniseriate epidermis around the mesophyll, and has only a few vestiges of oblique divisions on its margin (Pl. III. I).

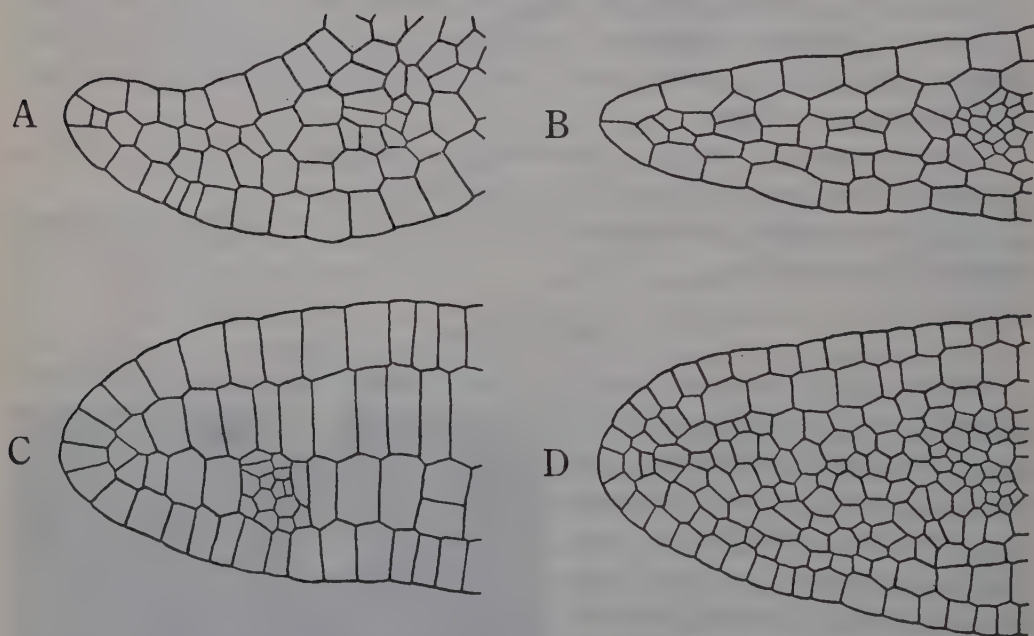


Fig. 2. Cross sections of the margins of the developing leaves. A. *Daphne odora* ($\times 400$), B. *Tripetaleia paniculata* ($\times 350$), C. *Clethra barbinervis* ($\times 400$), D. *Pieris japonica* ($\times 500$). The adaxial side of the leaf is shown in the upper side of the figure.

Tripetaleia paniculata. The initiation of the marginal growth can be obscurely recognized by the growth of marginal parts of the somewhat flattened cylindrical primordium. In this species there is no abnormal process of the marginal growth

as in the case of *Daphne odora*, but marginal initials divide only in anticlinal plane to the leaf margin, and finally give rise only to the uniseriate upper and lower epidermis. Submarginal initials divide obliquely, giving rise to the adaxial and abaxial layers. Subsequent periclinal divisions occur mainly in the adaxial layer (Fig. 2. B), and this layer gives rise to the middle layer which further differentiates into the middle mesophyll and the procambium, though very rarely there are exceptional instances in which the abaxial layer partly concerns to supply the cells to the middle layer. The upper mesophyll arises from the adaxial layer, and the lower mesophyll arises from the abaxial layer.

Clethra barbinervis. The initiation of the marginal growth is recognizable by protruding of marginal stripes on both sides of the adaxial part of the primordium. As in the case of *Tripetaleia paniculata*, marginal initials produce the upper and lower protoderms, which give rise to the upper and lower epidermis respectively, and submarginal initials divide in oblique plane, giving rise to the adaxial and abaxial layers. But in this species the abaxial layer concerns the formation of the middle layer, which gives rise to the middle mesophyll and the procambium (Fig. 2. C). The upper mesophyll arises from the adaxial layer, and the lower mesophyll from the abaxial layer.

Pieris japonica. The initiation of the marginal growth and the activity of the marginal initials are the same in the case of *Tripetaleia paniculata*. Marginal initials produce only the upper and lower protoderms. But, submarginal initials divide in periclinal and anticlinal planes repeatedly. The adaxial and abaxial layers arise from submarginal initials by their anticlinal divisions in regard to the leaf margin, and the middle one, by their periclinal divisions (Fig 2. D). Because submarginal initials give rise to directly three inner layers and marginal initials give rise to the upper and lower protoderms, the margin of the leaf has five layers at the position of the third cell from the marginal initial one. For that reason and active divisions of the middle layer in anticlinal plane to the leaf margin, the form of the margin of the developing leaf is round in the cross section, while the margin of the leaf of the other species used in this study is comparatively tapered. The procambium and the middle mesophyll arise from the middle layer, the upper mesophyll from the adaxial layer, and the lower mesophyll from the abaxial layer.

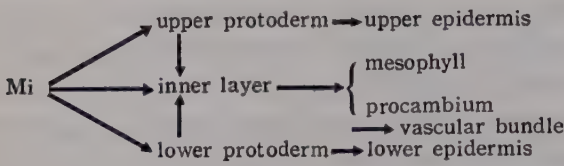
Summary and Discussion

In *Daphne odora* it is certain that submarginal cells are frequently replaced by new cells derived from marginal initials without any stable submarginal initial. Although the distinct boundary between the parts derived from the first and the second cell layers of the shoot apex cannot be determined, it is also sure that the greater part of the mesophyll and the procambium arises from marginal initials, excepting the median part derived from the second cell layer of the shoot apex. Thus, we can observe in this species that marginal initials divide in oblique and periclinal planes

Diagrams

Examples

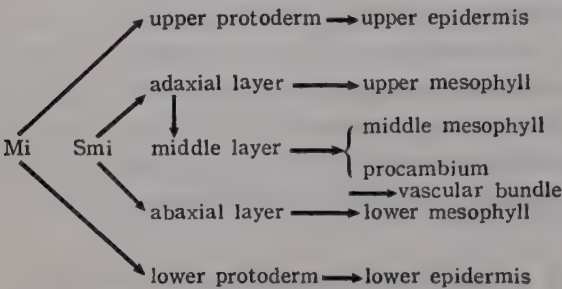
MARGINAL TYPE (Fig.4, A)



Daphne odora

SUBMARGINAL TYPE

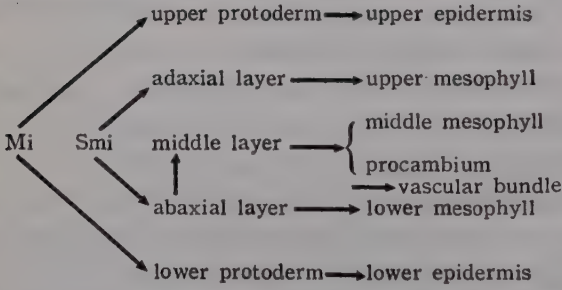
Adaxial Type (Fig. 4, B)



Drimys Winteri (Gifford, 1951)

Tripetaleia paniculata

Abaxial Type (Fig. 4, C)



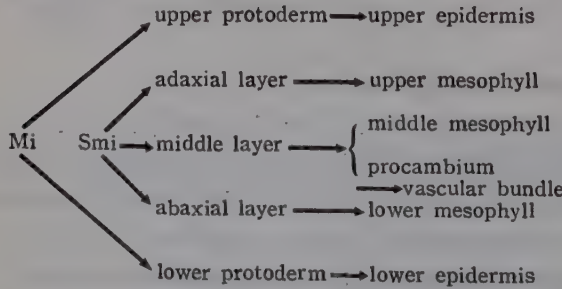
Carya buckleyi (Foster, 1935)

Morus alba (Cross, 1937)

Linum usitatissimum
(Girolami, 1954)

Clethra barbinervis

Middle Type (Fig. 4, D)



Pelargonium zonale
(Noack, 1922)

Nicotiana Tabacum
(Avery, 1933)

Gossypium hirsutum
(Gifford, 1953)

Pieris japonica

Fig. 3. Diagrams of types of the marginal growth.

to the leaf margin from the first till the later stages of the marginal growth. The present report may be perhaps the first of this type in ordinary foliage leaves of dicotyledons, since such a case has not been reported by any author excepting in variegated leaves.

The type observed in *Tripetaleia paniculata* is the same with the case of *Drimys Winteri* var. *chilensis* observed for the first time by Gifford (1951), because the procambium arises from the middle layer derived from the adaxial layer. *T. paniculata* offers the second instance of this type in dicotyledons.

Clethra barbinervis and *Pieris japonica* show the common types of dicotyledons respectively, which have already been discussed by Foster (1936, cf. Esau, 1953).

The writer recognized that there exist two major types, the "marginal" type and the "submarginal" type, in regard to the marginal growth of the ordinary foliage leaves of dicotyledons according to the origin of the procambium. The submarginal type can be subdivided into three; the "adaxial", "abaxial", and "middle" types. The procambium arises from the adaxial layer in the first type, from the abaxial in the second type, and, in the third type, from the middle layer which arises from the submarginal initials directly. These patterns of the marginal growth are represented diagrammatically in Fig. 3 (cf. Fig. 4).

The leaf of one species shows, however, not always the only one type, but there

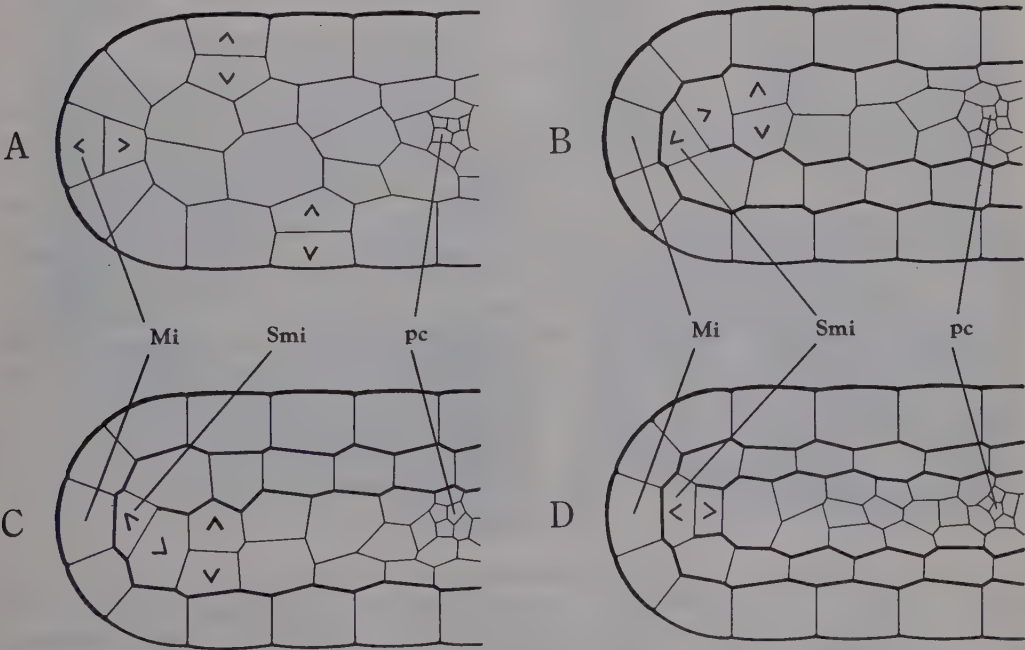


Fig. 4. Schematic representation of types of the marginal growth. A. Marginal Type, B-D. Submarginal Type, B. Adaxial Type, C. Abaxial Type, D. Middle Type, Mi: marginal initial cell, SMI: submarginal initial cell, pc: procambium. The adaxial side of the leaf is shown in the upper side of the figure.

are fluctuations in developmental stages even in one and the same lamina, as shown by Gifford (1951) and Schneider (1952), and in parts of one lamina, as shown by Girolami (1954). Moreover the type of the marginal growth can be shifted experimentally, as shown by Gifford (1953). Cross (1937b, 1938) reported that there are many variations in the form of submarginal initials in different leaves or along the margin of the same leaf. These facts suggest the existence of some intermediate conditions between the abaxial and middle types, and the writer also recognizes some examples of intermediate types in his extensive study on the Ericaceae and its allies (unpublished).

The outermost layer of the leaf primordium of dicotyledons as well as the first tunica layer of shoot apex differentiates commonly into an independent histogen, which corresponds to "dermatogen", and the process of the marginal growth of these plants usually shows only the submarginal type. In this regard it is very interesting from the phylogenetic standpoint that *Daphne odora* shows the marginal type in its leaf development, which may possibly be considered as a primitive feature in the vascular plants.

The author wishes to express his best thanks to Em. Prof. Y. Ogura and Dr. S. Watari for their kind direction and advices. Thanks are also due to Mr. K. Kasahara for valuable suggestion concerning the leaf development of *Daphne odora*.

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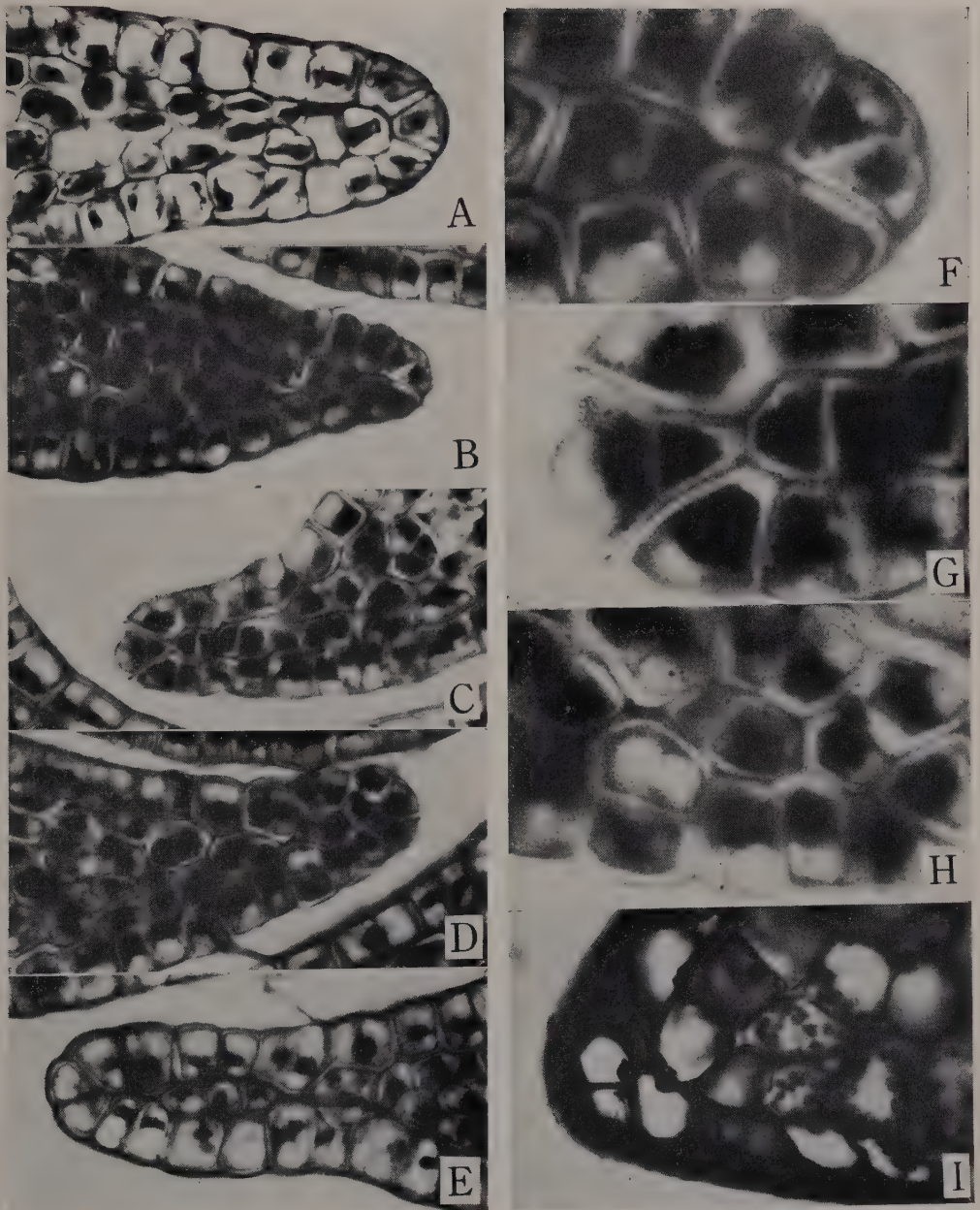


Plate III. Cross sections of leaves of *Daphne odora* (A-H: young developing leaves, I: mature leaf). The adaxial side of the leaf is shown in the upper side of the figure. A($\times 350$): ordinary form of the margin in dicotyledons. B($\times 400$), F(enlargement of B, $\times 1200$): oblique division of marginal initial cell, forming biserrate margin, C($\times 400$), G(enlargement of C, $\times 1200$): periclinal division of marginal initial cell, D($\times 400$), H(enlargement of D, $\times 1200$): periclinal divisions of derivatives from marginal initials, E($\times 400$): a few isolated mesophyll cells in biserrate margin, I($\times 350$): a vestige of oblique division of marginal initial cell.

N. Hara: On the types of the marginal growth in dicotyledonous foliage leaves.

Notes on Some Grasses V

by Tuguo TATEOKA*

館岡亜緒*: イネ科雑記 V

Received December 18, 1956

8. Systematic position of the genus *Astrebla*

The genus *Astrebla* comprises four species which are endemic in Australia; *A. squarrosa* C.E. Hubbard, *A. pectinacea* F. Muell., *A. lappacea* Domin and *A. elymioides* F. Muell. Benth. (1881), Hackel (1887), F. Ballard (1930) and Gardner (1952) referred this genus to Chlorideae. But Pilger (1954) placed it under Festuceae-Triodiinae together with the genera *Triodia*, *Plectrachne* and *Notochloa*. According to C.E. Hubbard (1928) *Astrebla* might be most closely allied to *Triodia*, especially such species as *T. lanigera* Domin and *T. mitchellii* Benth. As the species of *Astrebla* have been hitherto scarcely examined cytologically or anatomically, these views are wholly based on the characteristics of external morphology.

Samples of seeds of *A. lappacea* Domin and *A. pectinacea* F. Muell. were kindly supplied by Dr. W. Hartley and Dr. N. T. Burbidge. They were grown in our experimental garden. The author's observations of their chromosomes and leaf structure are reported below.

Chromosomes¹⁾—In both *A. lappacea* and *A. pectinacea* forty small chromosomes are observed in root tip cells (Fig. 1, E·F).

Leaf structure—Short club-shaped bicellular hairs and saddle-shaped siliceous cells are found in the upper and lower epidermis of both *A. lappacea* and *A. pectinacea* (Fig. 1, C·D). In the upper epidermis of both species, long white hairs are visible to the naked eye whose base has a sheath of epidermal cells. Vascular bundles of the two species are surrounded by inner and outer bundle sheaths. The latter is well developed and includes large amounts of chloroplasts. Surrounding the outer sheath, parenchyma cells are distributed radially. Motor cells are well developed. Mechanical cells are found above and below the vascular bundles. (Fig. 1, A·B).

As shown above, the leaf structure of the two *Astrebla* species falls under Chloridoid subtype of Panicoid type according to Prat's (1936) classification. Somatic chromosomes of *A. lappacea* were formerly examined by Brown (1950), who counted forty chromosomes in accordance with the author's finding. The characteristics of chromosomes and leaf structure of *Astrebla* species are in good agreement with

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1) Methods for chromosome observation—Root tips were fixed by Navashin's solution, dehydrated, and embedded in paraffin. Sections were cut at 15 micra, and stained by Newton's gentian violet method. All the figures were drawn with the aid of an Abbe drawing apparatus.

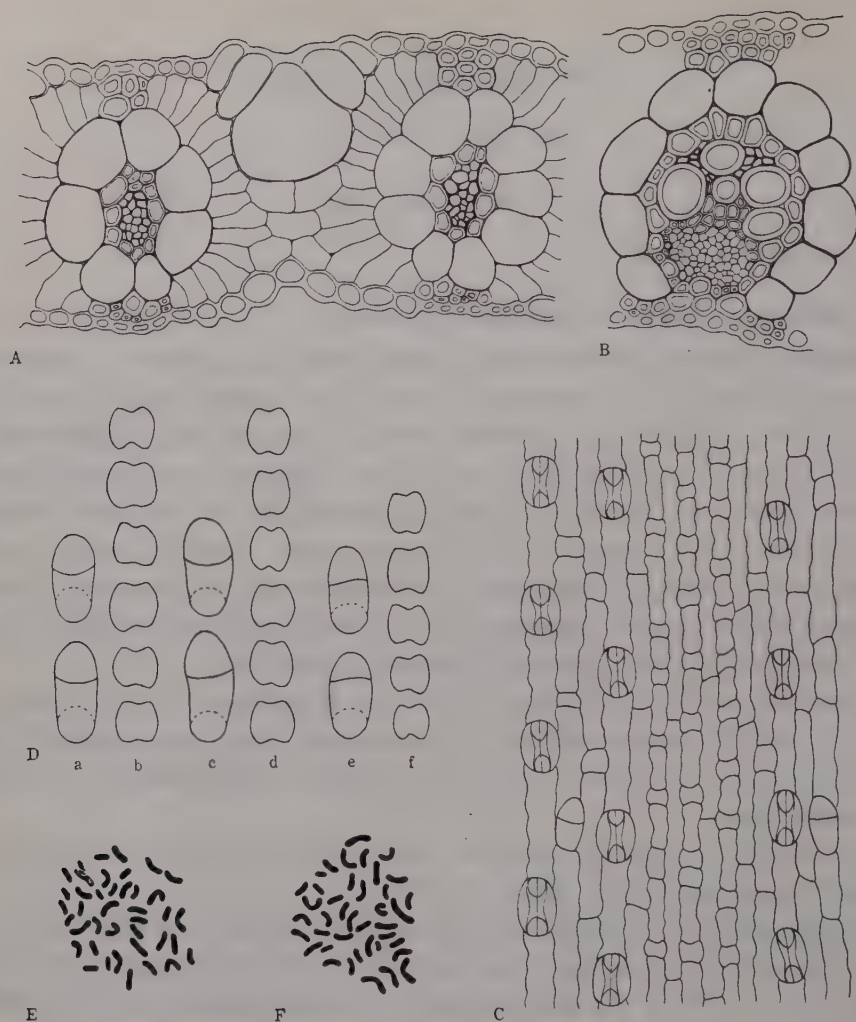


Fig. 1. A, B, Transverse leaf sections of *Astrebla lappacea* Domin $\times 300$. C, Lower epidermis of *A. pectinacea* F. Muell. $\times 300$. D, Bicellular hairs and siliceous cells $\times 450$. a-b, upper epidermis of *A. lappacea*. c-d, lower epidermis of the same species. e-f, upper epidermis of *A. pectinacea*. a, c, e, bicellular hairs. b, d, f, ciliceous cells. E, F, Somatic chromosomes $\times 2000$. E, *A. lappacea* $2n=40$. F, *A. pectinacea* $2n=40$.

those of many species of Chlorideae: with regard to leaf structure, they show Chloroid subtype, and in respect to chromosomes they have $b=10$ and the chromosomes are small. These findings indicate the systematic position of *Astrebla* in Chlorideae. The relationship between *Triodia* and *Danthonia* was maintained by Burbidge (1953), and de Wet (1956) mentioned the anatomical resemblance of the leaves of two *Danthonia* species, *D. cincta* Nees and *D. papposa* Nees, with those of some *Triodia* species whose leaf anatomy was examined by Burbidge (1946). In leaf structure and also in basic chromosome number, *Astrebla* is clearly different from *Danthonia*.

The latter has the basic chromosome number of six and its leaf structure is panicoid or festucoid, but not chloridoid (epidermis—mostly panicoid; transverse section—mostly festucoid) (de Wet 1954, 1956). While there are various reports on the chromosomes of *Tridens* species which were erroneously included in *Triodia*, chromosomes of *Triodia* sens. str. have not been examined. Further studies on *Triodia* will demonstrate its systematic position and its relationship to *Astrebla*.

I wish to express my cordial thanks to Dr. J. Ohwi and Dr. Y. Takenaka who gave me various valuable helps. My thanks are also due to Dr. W. Hartley and Dr. N. T. Burbidge who kindly supplied the seed samples.

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- 11) ———, Ibid. 43: 175 (1956).

本 会 記 事

役 員 移 動

4 月から本会役員が交代し、次のように依属されました。

幹 事

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抄

録

Küster, E.: Die Pflanzenzelle. Vorlesungen über normale und pathologische Zytomorphologie und Zytogenese. Dritte neubearbeitete Auflage. Unter Mitwirkung von K. Höfler herausgegeben von G. Küster-Winkelmann. Kap. II von G. Reese. 489 Abb. 986 S. Gustav Fischer, Jena 1956. DM 54,- (邦貨約 6000 円).

日進月歩の学問の分野では、新しい成果を追うあまり、ややもするとそれらの基礎となる古典との関連を失いがちである。細胞の研究についても同じことがいえる。Ernst Küster 著“植物細胞”を読んで第一に感ずることは、前世紀から現代に至る夥しい数の文献が極めて広範囲にわたって綿密に吟味され整然と体系化されて、最新の知識がその上にしっかりと根を下していることである。

本書の第1版は1935年に出版され名著と謳われたが戦後(1951)増訂第2版が出た。著者は長い間ギーゼン大学の教授として植物細胞学、病理形態学等に多くの業績を残し、著書だけでも約20冊に達する。本書は其中でも最大の労作である。K教授は1953年79才で歿したが、その後同じく植物学者である未亡人 Gertrud Küster 博士の編集と、ウィーン大学植物生理学教授 Höfler 博士の献身的な協力とによって、今回この増訂第3版が上梓されたのである。新版は第2版に比して更に120頁を加え図も多数追加されて、緒論や目次を入れると1000頁を越す大冊になっている。

内容は旧版と同様緒論にはじまって、I. 原形質, II. 細胞核, III. 色素体, IV. 澱粉及び糊粉粒, 結晶その他の死んだ内容物, V. 液胞, VI. 膜, VII. 細胞の発生, の7章からなり、各章末に詳しい引用文献のリストを載せている。文献のリストだけでも各章を通算すると165頁に達する。

本書の特色は、“正常及び病理細胞形態学並びに細胞発生に関する講義”という副題からもわかるように、細胞形態学だけでなく細胞発生理学、細胞病理学に及び、それらが渾然と融和してしかも全体として見事に統合されていることである。単細胞植物から藻類、菌類を経て高等植物の諸細胞に至る広汎な材料から随時随所に適例を引用して比較細胞学的な考察を試み、また実験細胞学的な解析を行っている。それらはこの著者の60年近いたゆまぬ研究生活の直接の体験を背景としたもので、本書に一段の生氣と迫力を与えている。本文は洗麗な文体で講義風に書かれ、在りし日のギュスター教授の名講義を眼前に彷彿とさせるものがある。その上、Höfler 教授が満一年間すべての余暇を本書の増補に費しただけあって、新しい重要な成果が各項目ごとによく紹介されていることは誠に喜ばしい。第2章(細胞核)だけはキール大学の Reese 博士によつて増補されているが、染色体及び正常核分裂に関する記述は旧版の伝統を守って全頁数の1/10以下に巧みに圧縮されている。この点は本書が他の多くの細胞学書とその趣を異にする点である。

本書は植物細胞の形態、発生、病理、機能等を包括した成書として現在われわれの持ちうる最高のものである。植物細胞について今までに何が知られ、まだ何が知られていないか、そしてどこに今後の問題があるかについて、本書は読者にとって貴重な指針となるであろう。細胞に関心をもつ研究者には見逃すことのできない書物である。今後植物細胞に関する知識はますます拡げられ深められてゆくであろうが、本書は永く古典としての価値を失わないであろう。

(神谷 宣郎)

Notes on Some Grasses VI.

by Tuguo TATEOKA*

館岡画緒*: イネ科雑記 VI.

Received December 18, 1956

§ 9. *Coelachne* and *Sphaerocaryum*

In 1943, C. E. Hubbard proposed to revive Bentham's (1881) tribe Isachneae for the genera *Isachne*, *Limnopoa*, *Heteranthoecia*, *Coelachne* and *Sphaerocaryum*. Potztal (1952) published an anatomical study of their leaf structure which brought forth interesting results. According to Potztal, the characteristics of their transverse leaf section show a striking similarity; they have in common a uniform chlorophyll distribution throughout the mesophyll and an outer (parenchymatous) bundle sheath which is more or less developed and does not contain chloroplasts. They reveal varying epidermal characteristics; *Coelachne Friesiorum* C. E. Hubbard, *C. Hackelii*, Merrill, *C. pulchella* R. Br., *Isachne rigidifolius* (Pois.) Urb. and *Limnopoa Meeboldii* C. E. Hubbard have no bicellular hairs, while twenty two species of *Isachne* and *Heteranthoecia isachnoides* Stapf bear threadlike bicellular hairs. In *Coelachne africana* Pilger threadlike bi-or multi-cellular hairs are found, and *Sphaerocaryum malaccense* (Trin.) Pilger has characteristic bicellular hairs, which are swollen and rounded at the apex, while the lower cell is sunken between the epidermis cells. In the shape of siliceous cells and also in the features of strigose cells various appearance are observed, but they are all included in Panicoid type according to Prat's (1936) classification.

The author examined the characteristics of epidermis and transverse leaf section of *Coelachne japonica* Hack. and gained some information of systematic significance. The results are presented below.

Leaf structure of *C. japonica*—In the epidermis, club-shaped bicellular hairs, whose lower cell is sunken among the epidermis cells, and strigose cells which have no epidermal sheath at the base are found. Siliceous cells are mostly cross-shaped. An inner (mesotome) bundle sheath is scarcely differentiated, and an outer (parenchymatous) bundle sheath is well developed. The parenchyma is radially arranged around the outer sheath which does not contain chloroplasts at all. The depression between the nerves consists mostly of two parenchymatous cell layers and the upper and lower epidermis. There are many intercellular spaces among the assimilative parenchyma. Mechanical cells are found above and below the vascular bundles. (Fig. 1).

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As the description and the figure show, the characteristics of transverse leaf section of this species are in agreement with those of Isachneae species examined by Potztal (1952). The club-shaped bicellular hairs whose lower cell is sunken, found in this species, are very similar to those found in *Sphaerocaryum malaccense*.

Potztal (1. c.) asserted that the latter species should be transferred to Sporoboleae because it possesses the

characteristic bicellular hairs and spikelets with one floret and 1-nerved lemma as often found in Sporoboleae. Although *Coelachne japonica* has such hairs as found in *Sphaerocaryum*, other species of *Coelachne* are different concerning this character; in *C. africana* threadlike bi- or multi-cellular hairs are found, while *C. Friesiorum*, *C. Hackelii* and *C. pulchella* have no bicellular hairs. Although various characteristics of epidermis are found among *Coelachne* species, they should not be separated since they exhibit closely related features of external morphology. Therefore, it may be assumed that *Coelachne* possesses a range of variation in the epidermal characteristics and the characteristic bicellular hairs found in *C. japonica* cannot be attributed to a phylogenetic difference between this one and other *Coelachne* species. The characteristic bicellular hairs found in *C. japonica* do not always infer a relationship to Sporoboleae, and the same is true of the bicellular hairs of *Sphaerocaryum malaccense*. The author cannot discuss in detail the systematic position of *Sphaerocaryum*, as he has no chance to examine exactly the external morphology of the genus, but he supposes that the remarkable resemblance between *Sphaerocaryum* and other Isachneae in the characteristics of transverse leaf section speaks in the favor of placing this genus in Isachneae; the spikelets of *Sphaerocaryum* may be regarded as derived from those of *Coelachne*.

§ 10. Chromosomes and leaf structure of several species

Chromosomes¹⁾ were observed in root tip cells. The sources of the materials are listed in Table 1. Chromosome number and sizes are as follows:

¹⁾ Methods for chromosome observation—Root tips were fixed by Navashin's solution, dehydrated, and embedded in Paraffin. Sections were cut at 15 micra and Newton's gentian violet method was used for staining. All the figures were drawn with the aid of an Abbe drawing apparatus.

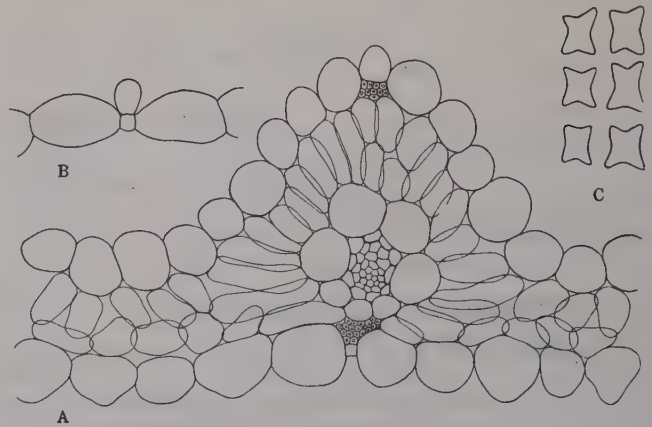


Fig. 1. *Coelachne japonica* Hack.

A. Transverse leaf section.

B. Bicellular hair whose lower cell is sunken between epidermis cells.

C. Siliceous cells.

Table 1. Sources of materials

<i>Cleistachne sorghoides</i>	Nelspruit, South Africa *
<i>Mosdenia phleoides</i>	30 miles NW of Pretoria, South Africa. *
<i>Ehrharta calycina</i> , <i>Themeda triandra</i>	Division of Crops and Pastures, Pretoria, South Africa
<i>Oryzopsis miliacea</i> , <i>Monerma cylindrica</i>	Botanischer Garten, Berlin-Dahlem **
<i>Schizachne purpurascens</i>	Mt. Yatsu, Nagano Pref., Japan ***
<i>Tripogon japonicus</i>	Fukuroda, Ibaragi Pref., Japan ***
<i>Coelachne japonica</i>	Kurotake, Shizuoka Pref., Japan ***

* Viable seeds of these species were kindly supplied by Dr. H. G. Schweickerdt.

** These plants were kindly offered by Dr. E. Potzta.

*** These species were collected by the present author.

1. *Tripogon japonicus* (Honda) Ohwi— $2n=20$, small. Fig. 2-1.
2. *Mosdenia phleoides* (Hack.) Stent— $2n=40$, small. Fig. 2-2.
3. *Monerma cylindrica* (Willd.) Coss.— $2n=26$, large. Fig. 2-3.
4. *Cleistachne sorghoides* Benth.— $2n=36$, small. Fig. 2-4.
5. *Themeda triandra* Forsk.— $2n=30$, small. Fig. 2-5.
6. *Coelachne japonica* Hack.— $2n=40$, small. Fig. 2-6.
7. *Schizachne purpurascens* Swallen— $2n=20$, small. Fig. 2-7.
8. *Oryzopsis miliacea* (L.) Benth. & Hook.— $2n=24$, small. Fig. 2-8.
9. *Ehrharta calycina* Sm.— $2n=24$, small. Fig. 2-9.

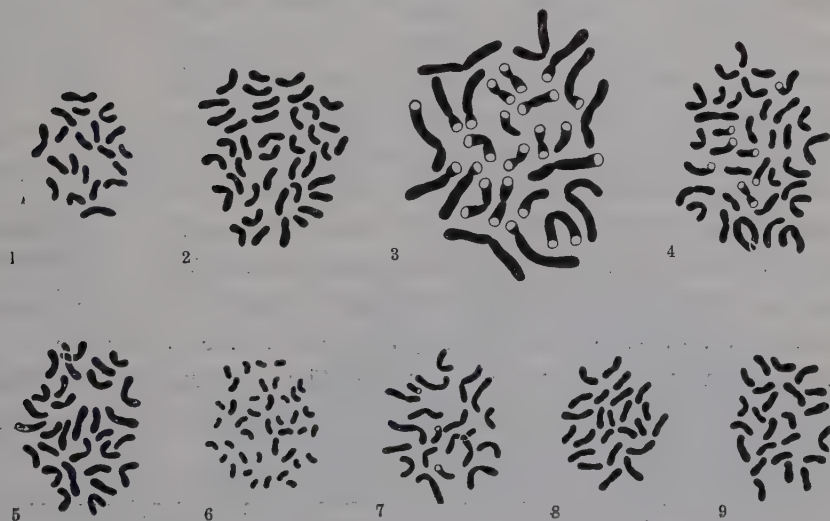


Fig. 2. Somatic chromosomes $\times 2000$. 1, *Tripogon japonicus* (Honda) Ohwi 2, *Mosdenia phleoides* (Hack.) Stent 3, *Monerma cylindrica* (Willd.) Coss. 4, *Cleistachne sorghoides* Benth. 5, *Themeda triandra* Forsk. 6, *Coelachne japonica* Hack. 7, *Schizachne purpurascens* Swallen. 8, *Oryzopsis miliacea* (L.) Benth. & Hook. 9, *Ehrharta calycina* Sm.

1. *Tripogon japonicus* (Honda.) Ohwi—The chromosomes of *Tripogon* species are here reported for the first time. The number 20 indicates the basic number of 10, which is also found in many species of Eragrosteae. The genus *Tripogon* is generally assigned to Eragrosteae. The examination of chromosomes supports such systematic treatment.

2. *Mosdenia phleoides* (Hack.) Stent—This genus has been hitherto neither cytologically examined nor was investigated in leaf structure. The chromosome number of 40 found in *M. phleoides* indicates a basic number of 10 in accordance with that of *Perotis*, *Tragus* and *Zoysia* which are placed under Lappagineae together with *Mosdenia*. The author's observations of the leaf structure of this species are as follows:

The inner bundle sheath surrounding the vascular bundles is scantily differentiated, while the outer bundle sheath is well developed and contains plenty of chloroplasts. Other assimilative parenchyma is arranged radially around the outer bundle sheath. Motor cells are well developed. Above and below the vascular bundles, mechanical cells are found. These cells are especially plentiful on the abaxial surface. In the upper and lower epidermis, elongated dumbbell-shaped siliceous cells are found. In the lower epidermis, club-shaped bicellular hairs are also observed.

As the description and the figure show, the characteristics of leaf structure of this species are the same as the Chloridoid subtype of Panicoid type. Other members of Lappagineae whose leaf structure has been examined up to now, show without exception Chloridoid subtype. The reference of Lappagineae to Eragrostoideae, as well as the relationship between *Mosdenia* and other Lappagineae, is apparently supported by the chromosome situation, leaf structure and external morphology.

3. *Monerma cylindrica* (Willd.) Coss.—The chromosomes of this species were formerly observed by Avdulov (1931) and Hunter (1934). Avdulov counted 26 chromosomes in root tip cells in agreement with the present author's observation, while Hunter reported $2n=52$ for the same species. The chromosome number of 26 is unusual in grasses, and Avdulov (l.c.) supposed that the 26 chromosomes might be derived through elimination of two chromosomes from nucleus with 28 chromosomes. His conjecture seems to be correct.

4. *Cleistachne sorghoides* Benth.—Garber (1950) reported $2n=36$ for this species. The present author's observation agrees with his finding. While the genus *Cleistachne* is related to *Sorghum*, the basic numbers of the two genera are different; the former shows $b=9$, and the latter has $b=5$. But with regard to chromosome size and morphology they are apparently similar.

5. *Themeda triandra* Forsk.—Avdulov (1931) reported 60 chromosomes for this



Fig. 3.

Mosdenia phleoides
(Hack.) Stent

A. Siliceous cells
 $\times 300$.

B. Bicellular hairs
 $\times 450$.

species designated as *T. Forskalii* Hack. The individual observed by the present author had $2n=30$ chromosomes. The basic chromosome number of *Themeda* is assumed to be 10 or 5 like in many other genera belonging to Andropogoneae, and the individual having $2n=30$ of *T. triandra* may have been triploid or hexaploid.

6. *Coelachne japonica* Hack.—The chromosomes of *Coelachne* species are reported for the first time. The chromosomes of this species are very small and the chromosome number of 40 indicates the basic number of 10. Chromosomes of Isachneae to which *Coelachne* is assigned were seldom examined, and only in *Isachne globosa* O. Kuntze 60 small chromosomes were found (Tateoka 1954.) The chromosome situation of the two species is similar.

7. *Schizachne purpurascens* Swallen—Boyle (1944) examined the chromosomes of this species in materials from North America. The present author's observation is in accordance with Boyle's report. While it has been since a long time debated whether *Schizachne* should be included in *Melica* or treated as a separate genus, Boyle (1.c.) pointed out the clear chromosomal diversity between them. The present author supports Boyle (1.c.) and others in the opinion that *Schizachne* must be separated from *Melica*.

8. *Oryzopsis miliacea* (L.) Benth. & Hook.—The plants examined by the author showed $2n=24$ small chromosomes in accordance with Avdulov's (1928) observation. The chromosome situation of this species is similar to that of other members of Stipeae in which *Oryzopsis* is placed.

9. *Ehrharta calycina* Sm.—This species was previously examined cytologically by Parthasarathy (1939) and Love (1948). Parthasarathy (1.c.) also observed the chromosomes of *E. erecta* Lam. and *E. longiflora* Sm. and also those of *Microlaena stipoides* (Labill.) R. Br. which is closely related to *Ehrharta*. From these studies, $b=12$ and small chromosome size were established for the species of *Ehrharta* and *Microlaena*. Prat (1936) referred the epidermal characteristics of *Ehrharta* and *Microlaena* to Panicoid type and the characteristics of transverse leaf section of

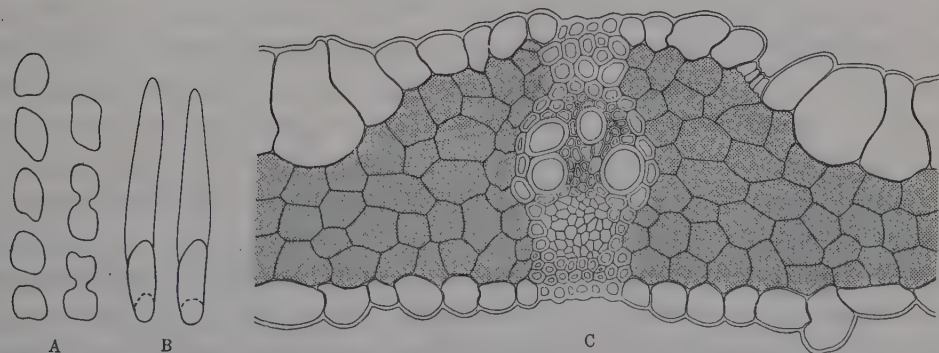


Fig. 4. *Ehrharta calycina* Sm. A. Siliceous cells $\times 450$. B. Bicellular hairs $\times 450$. C. Transverse leaf section $\times 300$.

Ehrharta to Festucoid type. The present author's observation of leaf structure of *E. calycina* is as follows:

Vascular bundles are surrounded by an inner bundle sheath, but the outer bundle sheath is scarcely differentiated. Chloroplasts are uniformly distributed throughout the mesophyll. Assimilative parenchyma possesses no cell wall processes and is disposed in a comb-like manner. Motor cell are well developed. On the upper and lower epidermis, threadlike bicellular hairs are found. Siliceous cells are either dumbbell- and saddle-shaped or rectangular.

As shown above, the features of transverse leaf section of this species apparently fall under the Festucoid type, and those of epidermis show the Panicoid type according to Prat's (1936) classification. These results are in accordance with Prat's (1936) record.

The genus *Ehrharta* together with *Microlaena* and *Tetrarrhena*, which are closely related to one another, is assigned to Oryzeae by several investigators. Schweickerdt and Marais (1956), Tateoka (1956, in press), a.o. examined the leaf structure of some members of Oryzeae. The members of Oryzeae possess cell wall processes in the assimilative parenchyma with the exception of *Chikusichloa aquatica* Koidzumi, and, also, their outer bundle sheath which is generally well developed never contains chloroplasts. In the epidermis, except for *Chikusichloa aquatica*, they have characteristic siliceous cells which have the shape of dumbbells placed transversely to the leaf blade (Oryzoid subtype). These features by which the leaf structure of Oryzeae is characterized cannot be found in *Ehrharta calycina*. The separation of the genera *Ehrharta*, *Microlaena* and *Tetrarrhena* from Oryzeae is also supported by the characteristics of spikelet structure. The three genera have spikelets including one fertile floret and two reduced ones like Phalarideae sens. str. Although Stapf (1910), Arber (1934), a.o. considered that the spikelet structure of Oryzeae is the same as that of the two groups indicated above, such a view met with opposition of recent investigators, as Pilger (1939), Parodi (1939), Nunez (1951), Schweickerdt and Marais (1956), a.o. According to Parodi (l.c.) and Pilger (l.c.) the upper two bracts found in Oryzeae spikelets which were ascribed to lemma and palea by Stapf and others are both lemmas for each of the two florets. Parodi (1939) treated Oryzeae as an independent subfamily, since he believed that such a spikelet structure as found in Oryzeae could not be found in other grass groups. Recently, Schweickerdt and Marais (1956) have offered another hypothetic interpretation of the spikelet structure of *Oryza*. They consider that the two bracts are lemma and palea of one floret, and the middle nerve of palea corresponds to the rachilla adherent to the palea. Although they take a stand against Parodi's view concerning the interpretation of spikelet structure of *Oryza*, they do not oppose the treatment of Oryzeae as an independent subfamily, because the spikelets of Oryzeae, especially its paleas, also according to them, possess peculiar characteristics. The paleas of *Ehrharta*, *Microlaena* and *Tetrarrhena* are membranaceous, showing a striking diffe-

rence from those of Oryzeae. On the other hand, the genera *Ehrharta*, *Microlaena* and *Tetrarrhena* are evidently different from the genera of Phalarideae sens. str. In the characteristics of chromosomes and leaf structure as well as in their distribution, although the two groups have many features in common in the spikelet characteristics, and various authorities have placed them in one and the same tribe, Phalarideae sens. lat. The two groups must be separated. The author is inclined to believe that those three genera should be treated as an independent tribe. The three genera are considered to make an isolated group without close relatives, but remotely related to the genus *Uniola*, the genera of Molinieae, etc.

I wish to express my cordial thanks to Dr. J. Ohwi and Dr. E. Potztal who gave me various useful advices and helps during the course of the present investigation. To Dr. Y. Takenaka, I owe special thanks for his interest and help in my work. My thanks are also due to Prof. Dr. H. G. Schweickerdt who kindly supplied various seed samples.

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Physiological Studies on Growth and Morphogenesis of the Isolated Plant Cell Cultured *in vitro* III.

The Effects of pH, Auxin and Metabolic Inhibitors

by Tadashi SANDAN* and Toshimi OGURA*

山段 忠*・小倉敏美*: 遊離植物細胞の生長成形に関する生理学的研究 III.
pH, オーキシシン及び代謝阻害剤の影響

Received December 28, 1956

An isolated internodal cell, a cell fragment obtained from the internodal cell and an isolated single rhizoid cell of Characeae are able to grow and develop a

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new shoot and rhizoids when they are cultured in agar gel with suitable culture solutions (Sandan, 1955⁽¹⁾ 1956⁽²⁾). In the present experiments the effects of pH, auxin and metabolic inhibitors upon the morphogenetic development and protoplasmic streaming of an isolated internodal cell cultured *in vitro* were observed.

Material and Method

An isolated internodal cell of *Nitella flexilis* which was about 3.0 cm in length and 400 μ in width was used as material. The materials were cultured in the vertical, normal position in a test tube filled by half with 0.6% agar gel according to the method described in the previous paper⁽¹⁾. In the present work solutions of potassium cyanide, sodium fluoride and monoiodoacetic acid were used as metabolic inhibitor and solutions of indole-3-acetic acid were applied as growth hormone. Furthermore, for the observation of the effect of pH, McIlvaine's citrate-phosphate buffer solutions (0.01 M citrate, 0.02 M phosphate) in various pH were applied. In the cases of auxin and metabolic inhibitors except potassium cyanide, Sørensen's phosphate buffer solution (M/50 for the metabolic inhibitors and M/100 for auxin), pH 6.6, was used as the basic culture solution (control). Also, in the case of potassium cyanide, McIlvaine's citrate-phosphate buffer solution at pH 7.0 (0.02 M citrate, 0.04 M phosphate) was applied as control.

For the removal of fungi and bacteria from the culture medium 0.5 mg of Trichomycin P tablet** and 0.2 mg of streptomycin were added to 50 cc of the culture medium. All experiments were carried out at room temperature under diffused light of about 80 lux.

As to the effects induced by these reagents upon the morphogenesis of the cell, the authors paid their attention to the next two points: first, the effect on the formation of a shoot and rhizoids from the cell, and second, the effect on the elongation of both a shoot and rhizoids which were newly formed. The former is represented as the time required by the material for shooting and forming rhizoids after it was brought into the culture medium, and the latter is measured as the length of shoot or rhizoid 30 days after cultivation. The rate of protoplasmic streaming in the cell being very sensitive to the change in temperature, the measurement of the velocity of flow was carried out according to the method described in the previous report⁽¹⁾. The values shown in the table are the averages of five experiments in each case.

Results

1 Effect of metabolic inhibitors

a) *Potassium cyanide*. As illustrated in Table 1, the rhizoid formation was slightly accelerated by 5×10^{-4} M KCN. By 1×10^{-3} M, shooting was completely

** Penicillin Trichomycin Vaginal Tablet manufactured by the Sanyô Chemical Co., Ltd.

inhibited, whereas rhizoid formation was not depressed. At or above 5×10^{-3} M, shooting and rhizoid formation were completely checked and the materials decayed gradually. At or below 2×10^{-4} M, the morphogenetic development was not affected.

b) *Monoiodoacetic acid* The rhizoid formation was completely inhibited by 4×10^{-3} M, whereas shooting takes place normally at this concentration. At or above 1×10^{-2} M, the materials gradually decayed after complete suspension of both shoot and rhizoid formation.

c) *Sodium fluoride* As shown in Table 1, by 1×10^{-3} M NaF the rhizoid formation was checked whereas shooting was not inhibited. At or below 5×10^{-4} M, the morphogenetic development of the cell was not affected, and at or above 4×10^{-3} M, the materials decayed after complete inhibition of morphogenesis.

Table 1. The effect of metabolic inhibitors on the morphogenetic development of the cell

Inhibitor	Conc. (M)	Time for shooting (days)	Length of shoot (cm)	Time for rhizoid formation (days)	Length of rhizoid (cm)
KCN	Control	14	1.4	14	1.6
	2×10^{-4}	14	1.4	14	1.6
	5×10^{-4}	18	0.6	11	1.8
	8×10^{-4}	23	0.3	13	1.6
	1×10^{-3}	no shooting	—	16	1.2
	2×10^{-3}	—	—	19	0.6
	5×10^{-3}	—	—	no rhizoid formation	—
CH ₂ ICOOH	Control	14	1.5	14	1.7
	1×10^{-3}	14	1.5	14	1.7
	2×10^{-3}	14	1.5	16	1.4
	4×10^{-3}	14	1.5	no rhizoid formation	—
	6×10^{-3}	17	1.2	—	—
	1×10^{-2}	no shooting	—	—	—
	—	—	—	—	—
NaF	Control	14	1.5	14	1.7
	5×10^{-4}	14	1.5	14	1.7
	8×10^{-4}	14	1.6	18	0.9
	1×10^{-3}	15	1.4	no rhizoid formation	—
	2×10^{-3}	18	1.1	—	—
	4×10^{-3}	no shooting	—	—	—
	—	—	—	—	—

2 Effect of auxin

a) *Effect on morphogenesis of the cell* The effect of auxin on the morphogenetic development of the cell was shown in Table 2.

According to the results, shooting and elongation of both shoot and rhizoid were promoted by 0.07–1.0 mg/l (optimum conc. was 0.1 mg/l), while rhizoid formation was accelerated by 0.07–10.0 mg/l (optimum conc. was 0.2 mg/l). At or below 0.05 mg/l, the morphogenetic development was not influenced, and at or above 40 mg/l, the materials decayed after complete inhibition of both shooting and forming rhizoid.

Table 2. The effect of auxin on the morphogenetic development of the cell

Auxin conc. (mg/l)	Time for shooting (days)	Length of shoot (cm)	Time for rhizoid formation (days)	Length of rhizoid (cm)
Control	16	1.2	16	1.5
0.05	16	1.2	16	1.4
0.07	14	1.4	15	1.7
0.1	12	1.8	14	2.1
0.15	13	1.5	14	1.7
0.2	13	1.4	12	1.7
0.5	13	1.4	13	1.6
1.0	13	1.3	13	1.6
5.0	16	1.2	14	1.5
10.0	16	1.2	14	1.4
20.0	16	1.2	16	1.4
30.0	24	0.6	19	0.2
40.0	no shooting	—	no rhizoid formation	—

b) *Effect on the protoplasmic streaming* The rate of the protoplasmic streaming was generally constant except for 4 or 6 days at the start of cultivation, when it decreases, and for several days prior to shooting, when it increases. The decrease in the rate of flow is probably due to the mechanical shock accompanying the culture treatment.

By 0.1-20 mg/l auxin, the rate of flow temporarily increased for two or three days after recovery to the normal rate from the diminished rate. By 0.1-0.2 mg/l, the accelerated rate continued for more than 40 days. At or below 0.05 mg/l, the rate of streaming was not affected. By 5.0-30.0 mg/l, streaming was not so constant as the one in control in general. By 30-40 mg/l, the accelerated stage in streaming was not recognized, and by 40 mg/l the streaming was stopped in five or six days and the cell decayed gradually.

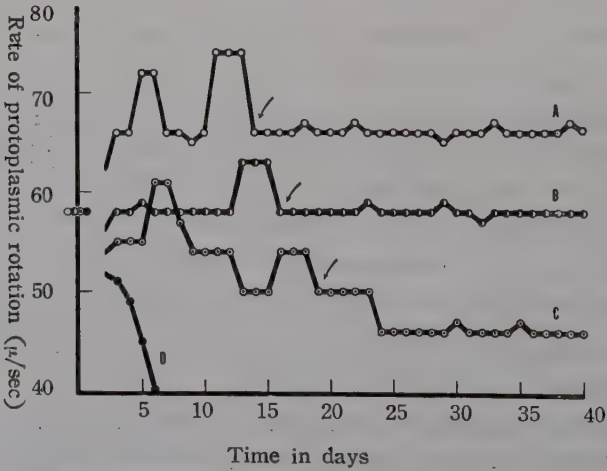


Fig.1. Relation between the rate of protoplasmic rotation in the cell and time.

A: 0.1 mg/l IAA B: Control
C: 25 mg/l IAA D: 40 mg/l IAA

At the times marked with arrow shooting was observed.

3 Effect of pH

As illustrated in Table 3, at pH 3 the cell was decayed in five days after complete suspension of the morphogenetic development. The optimum pH on the morphogenesis of the cell appears to be around of 6.6.

Table 3. Effect of pH on the morphogenesis of the cell

pH	Time for shooting (days)	Length of shoot (cm)	Time for rhizoid formation (days)	Length of rhizoid (cm)
3.0	no shooting	—	no rhizoid formation	—
4.0	18	0.6	19	0.2
4.6	16	0.9	16	0.7
5.0	15	1.2	15	0.9
5.6	15	1.3	15	1.2
6.0	15	1.3	15	1.3
6.6	14	1.4	13	1.6
7.0	16	1.2	16	1.3
8.0	23	0.4	21	0.3

Discussion

Kelso and Turner (1955)⁽³⁾ reported the action of various growth regulating substances on streaming in single cells of the staminal hair of *Tradescantia virginiana*. According to their description, IAA, when added alone, brings about changes in the rate of streaming within 10 min: the maximum effects are reached in 30 min, and the rate returns to the normal in 60–70 min. Low concentrations of auxin stimulate the streaming, high concentrations depress the rate and intermediate concentrations are without effect. The maximum positive effect is given at 1 mg/l for auxin. These results confirm those obtained by Thimann and Sweeney (1937⁽⁴⁾ 1938⁽⁵⁾) for *Avena* coleoptile, except that the concentration for auxin giving the maximum total effect for *Avena* is as low as 0.01 mg/l. The results of the present work showed that low concentrations of auxin stimulate the streaming in the cell of *Nitella* temporarily or permanently, and high concentrations depress the the rate. The present results are similar to those obtained by Kelso and Turner and by Thimann and Sweeney except the difference in effective concentration of growth hormone and the difference in periods in which the rate of flow was increased. By 0.1–0.2 mg/l, the streaming in the cell of *Nitella* was accelerated for more than 40 days.

Leonian and Lilly (1937⁽⁶⁾ 1941⁽⁷⁾), Yin (1937)⁽⁸⁾ and Brannon and Sell (1945)⁽⁹⁾ respectively reported the stimulating effect of IAA on the growth of *Chlorella* cell. Olson and duBuy (1937)⁽¹⁰⁾ cited experiments to show that the polarity of germinating zygote of *Fucus* could be determined by a high local concentration of IAA. They found no increase in the number of rhizoids formed when IAA was added. But Jacobs (1951)⁽¹¹⁾ observed that auxin promoted the rhizoid formation in *Bryopsis*.

In the present work auxin promoted shooting, rhizoid formation and elongation

of both shoot and rhizoid in low concentrations. The optimum concentration of auxin for shooting was different from the one for rhizoid formation, but the optimum concentration for elongation of shoot was the same as the one for elongation of rhizoid. These results may have a certain relation to the fact, which was previously reported by one of the authors²⁾, that a rhizoid cell cultured *in vitro* for a long time was metamorphosed into a miniature of an internodal cell after a full development.

The rhizoid formation was slightly promoted by 5×10^{-4} M KCN. By 1×10^{-3} M KCN, shooting was completely inhibited, whereas rhizoid formation was not suspended. Also, rhizoid formation was inhibited completely by 4×10^{-3} M CH_2ICOOH and by 1×10^{-3} M NaF, whereas shooting was not checked. KCN, which is a well known poison for cytochrome oxidase, seems to inhibit shooting remarkably, on the other hand, NaF and CH_2ICOOH , which are known as inhibitors for glycolysis, appear to check rhizoid formation strikingly.

Summary

1. Application of KCN in a low concentration to the isolated internodal cell of *Nitella* cultured *in vitro* results in slight promotion of rhizoid formation. The shooting from the cell was inhibited by KCN in certain concentrations whereas rhizoid formation was not affected.

2. By the treatment with CH_2ICOOH and NaF in certain concentrations, rhizoid formation was completely checked whereas shooting was not abated.

3. Auxin in low concentrations promoted the morphogenetic development. The protoplasmic rotation of the cells was also accelerated temporarily or permanently by application of auxin in low concentrations.

4. The optimum pH for the morphogenesis of the cell appears to be around 6.6.

The authors wish to express their most cordial thanks to Prof. N. Kamiya of Osaka University for his kind direction and helpful criticism throughout this work and also to Prof. T. Nakamura for his valuable advice.

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Miscellaneous Notes on Myriangiales from Japan III

by Eiichi KUROSAWA and Shigetaka KATSUKI

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Received January 9, 1957

(1) *Elsinoë batatas* Viegas et Jenkins

Journ. Washington Acad. Sci. **33**: (8): 248 (1943); Ling and Jenkins, Plant Dis. Rept. **35**: 120 (1951).

Syn. *Sphaceloma batatas* Sawada, Desc. Cat. Formosan Fungi **5**: 105 (1931); Goto, Ann. Phytopath. Soc. Japan **7**: 143-145 (1937).

Hab. and distr.:

On *Ipomoea batatas* var. *edulis* (Syn. *I. batatas*) (Satsumaimo).

South America (Brazil), Guam, Formosa, and China.

Specimens examined:

Kagoshima Pref.: Amami Island, Nov. 10, 1936, Yamasaki (SK 1412) (KU-K 13), Nov. 1937, Yamasaki (SK 1412) (KU-K 14), Oct. 3, 1954, S. K. (SK 668), Oct. 5, 1954, S. K. (SK 824), Oct. 10, 1954, S. K. (SK 1024), Kikai Island, Oct. 8, 1954, S. K. (SK 953).

(2) *Sphaceloma akebiae* Kurosawa et Katsuki sp. nov. (Fig. 1)

Maculis in foliis, sparsis vel secus nervos aggregatis, vulgo amphigenis, orbicularibus vel subcircularibus 0.2-2 mm. latis, saepe coalescentibus et extentis, planis vel leviter in medio depressis, primo brunneis dein griseo-albis vel ochraceo-alutaceas, margine nigrobrunneis vel purpureo-brunneis, in caulibus, magis elongatis 3-5 mm. centro depressis; in fructibus obscuro-brunneis 2-3 mm. saepe coalescentibus; fructificationibus subcuticularibus, postea erumpentibus, palis conidophoris compactis, 9-20 μ crassis, hyalinis, 5-7 \times 2.6-4 μ ; conidils continuis, hyalinis, ellipticis, 3.9-8 \times 2.0-3.3 μ .

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** Tōa Nōyaku Co. Ltd. 東亜農業株式会社

1. Abbreviations used in the citation of specimens and collectors: (IB)-Herb. Secção Fitopat. Inst. Riol., São Paulo, Brazil.

(NFC)-Herb. National Fungus Collection, U. S. Dept. Agr., Beltsville. Md., U. S. A.

(KU-K)-Herb. Dept. Plant. Path. Kyushu Univ. Japan.

(SK)-Herb. Shigetaka Katsuki.

(YNU)-Herb. Agr. Inst. Yokohama Nat. Univ., Yokohama, Japan.

E. K. ...E. Kurosawa S. K. ...Katsuki

2. Kurosawa, E. and S. Katsuki, Miscellaneous notes on Myriangiales from Japan (1) Ann. Phytopath. Soc. Japan **21** (1): 13-16 (1956); (2) Bot. Mag. Tokyo, **69**: (817-818): 315-318 (1956).

Fig. 1. *Sphaceloma akebiae*A. On leaves ($\times 1/2$)B. Conidiophores and conidia ($\times 1000$)

Hab. and distr.:

On *Akebia quinata* (Akebi), *A. trifoliata* (Mitsuba-akebi) and *Stauntonia hexaphylla* (Mube) (Lardizabalaceae).

Specimens examined:

On *Akebia quinata*

Ibaraki Pref.: Mt. Tsukuba, June 17, 1933, E. K. (SK 1494); Aug. 15, 1935, E. K. (SK 1945); Itabashi, May 22, 1937, E. K. (SK 1496).

Kanagawa Pref.: Taisho-mura, May 22, 1938, E. K. (SK 1499); Totsuka, May 10, 1938, E. K. (1500).

Chiba Pref.: Matsudo, Sept. 12, 1938, E. K. (SK 1502 & 1503).

Yamanashi Pref.: Shore of Lake Kawaguchi, July 7, 1951, E. K. (SK 1507).

Tokyo: Hirayama, Oct. 7, 1951, E. K. (SK 1508).

Kagoshima University, Aug. 13, 1951, S. K. (YNU-K3) (IB 5681) (NFC 91048).

On *Akebia trifoliata*

Gunma Pref.: Tanigawa, July 19, 1936, E. K. (SK 1497) (IB 5994) (NFC 91087) (KU-K 64); (SK 1498) (KU-K 65) (Type).

Tokyo: Mt. Takao, Dec. 3, 1950, E. K. (SK 1504).

Fukuoka Pref.: Botanical Garden of Kyushu University, June 29, 1951, S. K. (SK 1505-1509); May 23, 1956, S. Yamamoto (KS 3296).

Yamanashi Pref.: Shore of Lake Kawaguchi, July 7, 1951, S. K. (SK 1506) (KU-K 69).

On *Stauntonia hexaphylla*

Kagoshima Pref.: Botanical Garden of Kagoshima University, Oct. 26, 1949, S. K. (SK 1510); Aug. 13, 1951, S. K. (YNU-K 2) (IB 5685) (NFC 1054).

(3) *Sphaceloma japonicus* Kurosawa et Katsuki sp. nov. (Fig. 2)

Maculis in foliis circularibus, paucis vel numerosis minutis, 0.1-0.5 mm.

diametro, plerumque epiphyllis interdum amphigenis, sparsis vel aggregatis, griseo-albidis, interdum purpureo-marginatis; acervulis erumpente superficialibus; conidiophoris ex mycelio intercellulari vel stromatis, rectis vel sinuosis, raro ramosis, apice attenuatis, continuis vel 1-2 septatis, subhyalinis, $6-23 \times 2.6-3.5 \mu$; conidiis fusiformis, continuis vel 1 septatis, hyalinis, $3.3-6.6 \times 2.0-3.9 \mu$, plerumque $5.3 \times 2.6 \mu$.

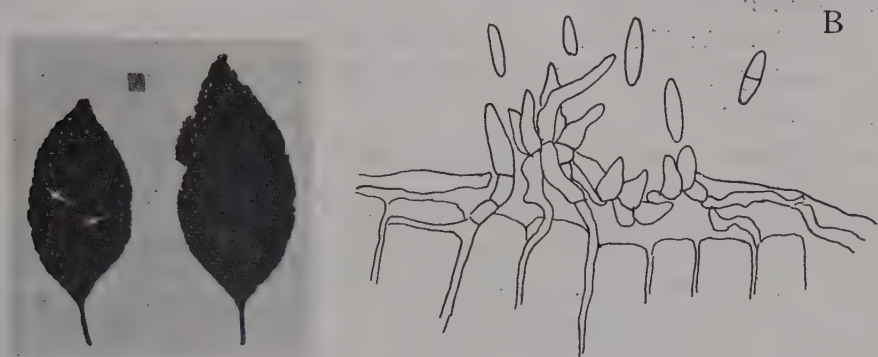


Fig. 2. *Sphaceloma japonicus*

A. On leaves ($\times 1$)

B. Conidiophores and conidia ($\times 1000$)

Hab. and distr.:

On *Ilex serrulata* var. *sieboldii* (Umemodoki) (Aquifoliaceae).

Specimens examined:

Saitama Pref.: Hatogaya, Sept. 5, 1938, E. K. (SK 1484)(KU-K 56)(Type); Sept. 27, 1938, E. K. (SK 1486)(KU-K 58)(NFC 91083)(IB 5988).

Chiba Pref.: Matsudo, Sept. 12, 1938, E. K. (SK 1485); Sept. 25, 1938, E. K. (SK 1488)(KU-K 59); Sept. 14, 1951, E. K. (SK 1487).

Remarks. Fortunately the junior writer could examine in detail the type specimen (IB 5354) (USM 90804) and paratype (IB 5353) (USM 90803) of *Elsinoë ilicis* Plakidas (Phytopath. 40:22, 1950) on *Ilex cornuta* sent by Dr. Jenkins. The leaf spot produced by *S. japonicus* is very unlike that represented by these specimens.

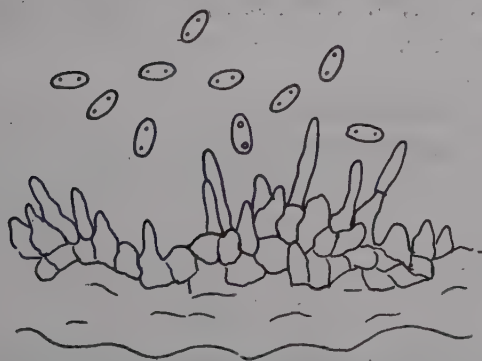


Fig. 3. *Sphaceloma lespedezae* Conidiophores and conidia ($\times 1000$)

(4) *Sphaceloma lespedezae* Kurosawa et Katsuki sp. nov. (Fig. 3)

Maculis in foliis, amphigenis, autem infra numerosis quam supra, subcircularibus vel irregularibus, 1-3 mm. diametro, occasionem confluentibus, etiam saepe nervos locatis, linearis vel irregularibus, supra castaneo-brunneis, infra ochraceo-alutaceas; acervulis sparsis, amphigenis, superficialibus, $32-64 \mu$ in diam., conidiophoris et mycelio intercellulari vel

stromatis, pausis vel 5-6, simplicibus continuis vel 1 septatis, hyalinis, $6-16 \times 2.6-3.5 \mu$; conidiis ellipticis, hyalinis, $4-8 \times 3-5 \mu$.

Hab. and distr.:

On *Lespedeza bicolor* (Hagi) and *L. buergeri* (Kihagi) (Leguminosae).

Specimens examined:

On *L. bicolor*

Yamanashi Pref.: Shore of Lake Motosu, July 8, 1951, E. K. (SK 1489) (KU-K 60) (SK 1490-1492) (KU-K 61-62) (IB 6636) (NFC 91283).

On *L. buergeri*

Tokyo.: Kasumi-mura, Minamitama-gun, Aug. 8, 1951, E. K. (SK 1493) (KU-K 63) (IB 6637) (NFC 91284) (Type).

(5) ***Sphaceloma peucedani* Kurosawa et Katsuki sp. nov.** (Fig. 4).

Maculis in foliis, amphigenis, sub-circularibus vel parum irregularibus, supra margine bine elevato, centro depressis, griseo-brunneis, frequenter perforatis, 1-2 mm. latis, in caulibus magis fusiformibus vel elongatis, margine elevato, obscuro cinctis, centro depressis, 2-8 mm. longis, saepe confluentibus; sporodochiis primo intra-epidermicalibus, postea erumpentibus, conidiophoris fasciculatis, erectis vel parum flexuosis, continuis, $21-50 \times 2.6-3.3 \mu$; conidiis continuis, hyalinis, ellipticis, $4-8 \times 2.6-4 \mu$.

Hab. and distr.:

On *Peucedanum decursivum* (Nodake) (Umbelliferae).

Specimens examined:

Kanagawa Pref.: Ohkusu-yama, Sept. 15, 1940, E. K. (SK 1512) (Type) (KU-K 70) (NFC 91095) (IB 6000); (SK 1513-1514) (KU-K 71).

(6) ***Sphaceloma plantaginis* Jenkins et Bitancourt**

Jour. Wash. Acad. Sci. 36: (7): 225-227 (1946); Katsuki, Kyushu Agr. Research 12: 53 (1953).

Hab. and distr.:

On *Plantago major* var. *asiatica* (Ohbako).

Formosa and North America

Specimens examined:

Ibaraki Pref.: Narado, Oct. 11, 1938, E. K. (SK 1416) (KU-30) (IB 5975); Gotanda, Oct. 8, 1939, E. K. (SK 1417); Nov. 19, 1939, E. K. (SK 1418) (KU-K 33).



Fig. 4. *Sphaceloma peucedani*

A. On leaves (1/3)

B. On Stem (1/2)

Tokyo: Hachiohji, Aug. 8, 1951, E. K. (SK 1420); Tama-Bochi, Sept. 32, 1951, E. K. (SK 1422); Inogashira Park, Oct. 26, 1951, E. K. (SK 1423)(KU-K 31); Toyoda, Sept. 10, 1951, E. K. (SK 1421); Saginomiya, Oct. 17, 1937, E. K. (SK 1415).

Yamanashi Pref.: Shore of Lake Kawaguchi, July 7, 1951, E. K. (SK 1419).

Kanagawa Pref.: Yokohama, June 6, 1937, Sakaguchi (SK 1414)(KU-K 32).

Fukuoka Pref.: Mizuwake-mura, Ukiha-gun, July 11, 1951, S. K. (SK 1511)(IB 5916).

Kagoshima Pref.: Kikai Island, Oct. 9, 1954, S. K. (SK 1011).

(7) *Sphaceloma rosarum* (Pass.) Jenkins

Jour. Agr. Res. **45**: 330, (1932); Goto, Phytopath. Soc. Japan **7**: 38-40, (1937).

Hab. and distr.:

On *Rosa chinensis* (Koshinbara), *R. multiflora* (Nobara) and *R. sp.*

South & North America, Europe Australia, China and Japan.

Specimens examined:

On *Rosa chinensis*

Hiroshima Pref.: Yoshida, Aug. 1926, K. Goto (SK 1434)(KU-K 34).

On *Rosa multiflora*

Kanagawa Pref.: Totsuka, May 22, 1938, E. K. (SK 1438)(KU-K 36).

On *Rosa sp.*

Tokyo: Higashinagasaki, May 10, 1937, E. K. (SK 1435); Negishi, April 30, 1939, E. K. (SK 1440)(KU-K 37).

Kanagawa Pref.: Totsuka, Aug. 1937, E. K. (SK 1436); May 22, 1938, E. K. (SK 1437) (KU-K 35); May 22, 1938, E. K. (SK 1438); May 20, 1938, E. K. (SK 1439).

Chiba Pref.: Matsudo, Oct. 10, 1939, E. K. (SK 1441) (KU-K 38).

(8) *Sphaceloma violae* Jenkins

Massey and Jenkins, Cornell Univ. Agr. Exp. Stat. Mem. **176**: 7, (1935); Brien and Dingley, New Zealand, Jour. Sci. and Tech. Sect. A. **34**: 561 (1951); Katsuki, Jour. Jap. Bot. **28** (9): 284 (1953); Jenkins and Bitancourt, O Biológico **21**: 208, (1955).

Hab. and distr.:

On *Viola odorata* (Nioi-sumire), *V. grypceras* (Tachitsubo-sumire), *V. grypceras* var. *exilis* (Kotachitsubo-sumire) and *V. okuboii* (Maruba-sumire).

North America, South America (Brazil), Australia, New Zealand, Africa and Formosa.

Specimens examined:

On *Viola odorata*

Chiba Pref.: Matsudo, Oct. 3, 1938, E. K. (SK 1455) (IB 5977) (NFC 90178); Sept. 25, 1939, E. K. (SK 1456).

On *Viola grypceras*

Kanagawa Pref.: Jinmuji, May 23, 1940, E. K. (SK 1457) (IB 5978) (NFC 91077).

Tokyo: Mt. Takao, Oct. 14, 1936, E. K. (SK 1410); Tama-Bochi, Aug. 10, 1950, E. K. (SK 1458); Nanao-mura, Sept. 30, 1950, E. K. (SK 1459); Inogashira Park, Oct. 17, 1951, E. K. (SK 1409) (KU-K 16).

On *Viola grypoceras* var. *exilis*

Kagoshima Pref.: Isso, Yaku Island, Aug. 5, 1951, Togashi and S. K. (SK 31) (IB 5680) (NFC 91062).

On *Viola okuboi*

Tokyo Mt. Takao, Oct. 14, 1936, E. K. (KU-K 15) (SK 1410).

S. Violae has not been reported previously from Formosa.

But the specimens [one on *V. odorata* (SK 1454) the other on *V. sp.* (SK 1453)] collected by Kurosawa there in 1930, are preserved by the junior author.

Acknowledgement

The writers wish to express their hearty gratitude to Dr. Jenkins and Dr. Bitancourt for their constant guidances and various aids rendered in the course of present study.

受精によるキカノコユリ (*Lilium speciosum* Thunb.) 子房の呼吸能の変化

松 村 正 義*

Masayoshi MATSUMURA*: Changes in the Respiratory Activity of the Ovaries of
Lilium speciosum Thunb. Caused by Fertilization

1956 年 11 月 14 日受付

受精は生物の生活史における最も重要な現象の一つである。とくに高等植物の受精に関しては早くから多くの研究があり、既に幾多の形態学的観察がなされている。ところが受精現象と呼吸との関係についての研究は動物材料については、しばしば報告されているにかかわらず、植物を材料とした研究は極めて少い。White (1906) による *Lilium candidum* の研究は方法も古く再検を要する。また Hsiang (1950) による *Cymbidium lowianum* の研究は受精と呼吸量の変化についてのみ行われたもので、受精すなわち雌雄核の合着及びその後の発生過程における呼吸の変化について、行われたものではない。

本研究はキカノコユリ (*Lilium speciosum*) の受粉以後胚発生初期までの間における呼吸能や R.Q. の変化と、組織学的変化との関連を明らかにする目的で行ったものである。

材料及び方法

材料は京都大学園場で栽培されたキカノコユリ (*Lilium speciosum*) を使用した。先ず、相当数の花が出揃う時期を見はからい、測定の前日に翌朝開花するはずの蕾を除雄した後袋かけをしておく。翌朝、右の袋かけをした蕾の中、だいたい同時刻に開花したものを選び、実験区と対照区とに分ける。対照区の花は受粉を避けるために再び

袋で包む。実験区の花は受粉させる (受粉時間は午前 8 時に一定した)。受粉時を出発点として、以後所定時間毎に、対照区、実験区よりそれぞれ所要数の雌ずいを採集、速やかに子房部分を分けとり (子房を傷つけないようにして花柱をとり除き、子房部分のみ検圧計の容器に移す) 検圧実験にかける。ワールブルグ検圧計使用。生鮮量約 1g (子房の発育に応じて 1 乃至 3 個に当る)**の材料を容器主室に入れる。媒液は添加しない。検圧計は毎回温度補正 1. 実験区 2. 対照区 2 の 5 本を使用する。実験区対照区共に 1 本は O_2 吸収量 (副室に 10% KOH 0.5 cc を添加)、他の 1 本は CO_2 放出量 (副室には何も入れない) を求める為に使用した。実験期間: 毎年 7 月中旬 ~ 8 月中旬の開花期、実験条件: 暗所; 室温 $29^{\circ} \pm 1^{\circ}C$; 恒温槽 $32^{\circ} \pm 0.2^{\circ}C$; 1 時間 検圧実験終了後、供試材料の一部をただちに固定 (Bouin's fluid)、パラフィン切片を作製して検鏡する (染色は、Delafield's hematoxylin)。供試材料の他の一部は、 $110^{\circ}C$ で 1 時間乾燥、ついで除湿器に移し一定重量となるまで放置した後、乾燥量 (D. W.) を測定する。この実験は、1946, 47, 及び 51 年の 3 回、それぞれ 3~5 回宛くりかえた。各年次にだいたい同傾向の結果が得られたので、以下には便宜上 1947 年度の結果を代表例として記すことにする。

研究結果

1. 呼吸量の変化

受粉した雌ずいの子房の O_2 消費速度 (cmm $O_2/hr/g$. D. W., 以下これを Q_{O_2} と記す) は (第 1 図 1947 年測定), 受粉後 80~90 時間迄は多少の増減はあるがとくに大きな変化は示さな

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** 子房 1 個の平均生鮮量は受粉時: 0.25 g, 100 時間後: 0.46 g, 200 時間後 0.98 g であった。なお、乾量と生量の比は平均して受粉時: 0.17, 100 時間後: 0.18, 200 時間後: 0.20 であった。

かった。ところが、受粉後90時間附近で急に著しい Q_{O_2} 増加(約40%)が認められた。これを第一上昇期と呼ぶ。更に受粉後200時間を経たもので再び急激な増加が見られた。これを第二上昇期と呼ぶ。

また、同じ材料について求めた R. Q. は(第2

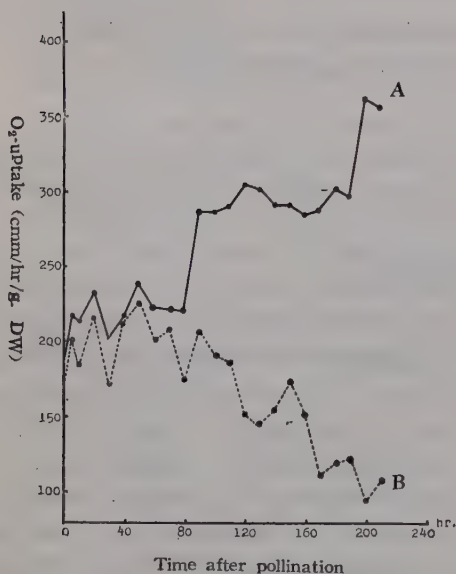


Fig. 1. Q_{O_2} -uptake (Q_{O_2}) by excised ovary of *Lilium speciosum* as influenced by pollination (The ovaries were excised at varied period after pollination as indicated in abscissa). A: pollinated, B: control, unpollinated.

図) 受粉後80時間迄は、1.10~1.25の値を示したが、受粉後90時間前後にかなり急激な上昇(1.3)があり、以後徐々に上昇を続けて200時間では1.43に達した。

次に対照区(未受粉)の子房の Q_{O_2} は実験区(受粉)の子房に比較してはじめやや低い値を示すが、90時間後においても何等の増加も認められないばかりか、その頃より明瞭な減少の傾向をあらわす(第1図)。また、対照区の R. Q. は、80時間迄は、実験区と大差ないが、それ以後徐々に低下し、200時間後にはほとんど1になった(第2図)。

2. 組織学的観察

観察に当っては、とくに受精が受粉後およそ何時間位で行われるかに注意した。受粉後80~90時間の雌ずいでは雌雄核の接着又は合着像が多数見受けられた(第3及び第4図)。受粉後200時間前後では遊離核分裂、そして220時間後には胚形成の初期の像が見られた(第5及び第6図)。

考 察

第1, 2図に示すごとく、受粉直後の雌蕊の子房の Q_{O_2} には、対照(未受粉)材料のそれと比較して、ほとんど差は認められない。受粉後80時間迄に Q_{O_2} に多少の増減が見られるのは、受粉によって、子房組織の生理的条件に変動、たとえば組織内酵素の活性変化が起るためと想像さ

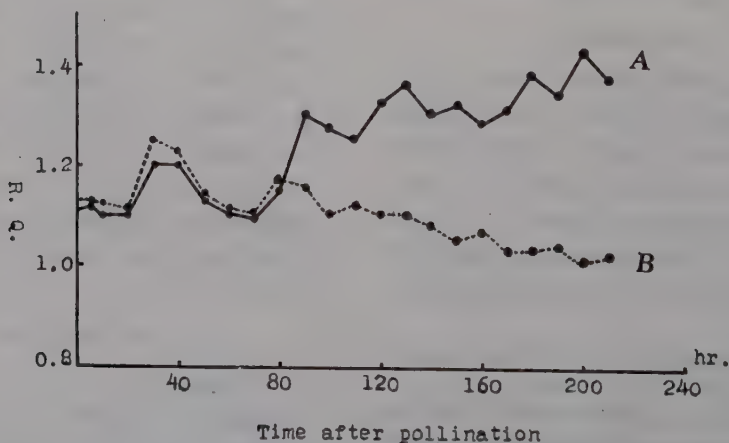


Fig. 2. R. Q. of ovary of *Lilium speciosum* as influenced by pollination. (The ovaries were excised at varied period after pollination as indicated in abscissa). A: pollinated ovary, B: control, unpollinated.

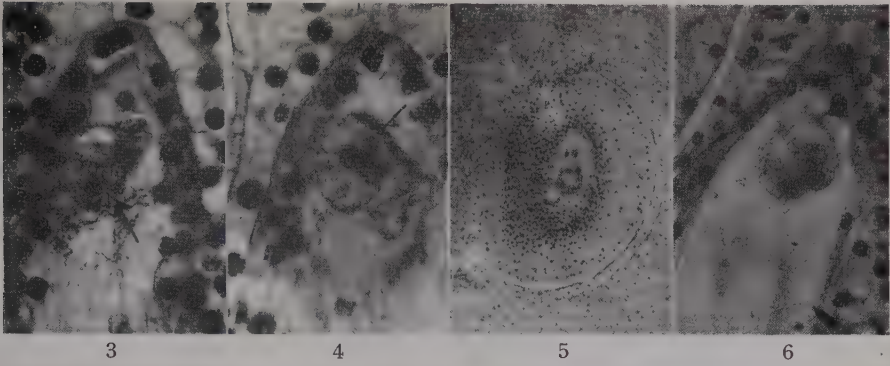


Fig. 3. Fertilized egg nucleus (90 hours after pollination). $\times 700$

4. Male and female nuclei are conjugating together (90 hours after pollination). $\times 700$
5. Free-nuclear divisions are seen in the endosperm (200 hours after pollination). $\times 200$
6. Developing embryo (220 hours after pollination). $\times 700$

れる。しかしこの場合の Q_{O_2} の変化は比較的小さく、したがって、受粉が子房組織の生理的条件に影響を与えたとしても、その程度は余り大きなものとは考えられない。受粉後 90 時間（第一上昇期）及び 200 時間（第二上昇期）の二つの時期において Q_{O_2} が飛躍的に増加した。第一上昇期は、雌雄核合着（受精）が営まれている時期に当る（第 3 及び第 4 図）ので、受精による卵細胞の呼吸促進ということも考えられるが、それだけではおそらくこの著しい Q_{O_2} 増大（約 40% の上昇）を説明することはできないであろう。むしろ受精が刺激となって子房組織自体の呼吸促進が惹起されたものと解すべきであろう。しかしこれらの点については今後の研究により結論を得ようと思っている。受精と呼吸能の関係については、White (1904) が *Lilium candidum* で 34% 増加（受粉後 90 時間）、Hsiang (1951) が *Cymbidium lowianum* で 3 倍増加（受粉後 48 時間）を認めているが、両氏の研究と本実験とは材料及び測定方法にかなりの相違があるので、これらを同一に論ずることは困難であり、今のところ何もいえない。

い。

次に第二上昇期（受粉後 200 時間）であるが、この時期においては、対照区の子房は凋萎し、その胚嚢内部には何等の分裂的变化がみとめられないのに受粉した胚嚢内では、遊離核分裂が盛んに行われている。 Q_{O_2} の第二上昇期は、おそらくこの核分裂と何等かの関係を有するものと考えられる。次に R. Q. は第 2 図に示したごとく、受粉の 90 時間後、すなわち Q_{O_2} に関しての第一上昇期と時間的に符合して、R. Q. 値に突然飛躍的な上昇が見られた。この急上昇は短時間でおさまるが、R. Q. 値は、以後も、ゆっくりと、しかし大体安定な歩調で上昇し続ける。第一上昇期の出現は、受精現象を刺激として、子房組織の呼吸が促進されることに基くと考えたが、上の R. Q. 変化は、受精を契機として子房組織のガス代謝には何等か重大な質的变化がしかも急激に起こることを示唆する。この点は、今後の実験で検討したいと思う。

最後に本研究の御指導をして頂いた恩師、新家浪雄教授に厚く感謝の意を表する。

Résumé

Respiratory activity (Q_{O_2}) and R.Q. of the ovary tissues of *Lilium speciosum* isolated at various stages of fertilization were estimated. Histological examinations were conducted in parallel. The results obtained are as follows:

1. Q_{O_2} showed little change by the pollination.

2. Q_{O_2} increased markedly at the period 90 hours after pollination, when the conjugation of male and female nuclei was observed.
3. The second increase of Q_{O_2} came 200 hours after pollination, when free-nuclear divisions took place in the endosperm.
4. Marked increase of R. Q. was observed at the period 90 hours after pollination. This abrupt rise in the R. Q. value was followed by a steady increase.

Literature cited

- 1) Hsiang, T.H.T., Plant Physiol. 26: 708-710 (1951).
- 2) White, J., Ann. Bot. 21: 487-499 (1907).

パン酵母とクロカビにおける発酵と浸透価の関係

高 見 亘*

Wataru TAKAMI*: Relation between Fermentation and Osmotic Value in *Saccharomyces cerevisiae* and *Aspergillus niger*.

1956 年 12 月 20 日受付

酵母やカビの発酵に関する多くの研究のうち、発酵過程における浸透価の変動について報告されたものはないといってよい。酵母やカビの正確な浸透価は測りにくい。ことに酵母菌体では Beet-lestone⁽¹⁾ が指摘したように、測定時容積が減少するので異常に高い浸透価を与える。しかし、発酵進行に伴う実側浸透価の相対的変動は著明である。ここにはパン酵母とクロカビについて得られた結果を報告する。

材料及び方法

市販のパン酵母と当大学でクエン酸発酵の研究用に分離した No. 588 のクロカビを用いた。酵母の培養液は次の組成である。

ぶどう糖……60 g $MgSO_4 \cdot 7H_2O$ ……5 g
 NH_4NO_3 ……0.75 g 蒸留水 (pH 5.8) ……1000 cc
 KH_2PO_4 ……5 g
 クロカビの培養基は次の如くである。
 しょ糖……140 g $MnSO_4 \cdot 4H_2O$ ……0.02 g

NH_4NO_3 ……2 g $FeCl_3 \cdot 6H_2O$ ……0.024 g
 KH_2PO_4 ……2 g 麦芽汁……20 cc
 $MgSO_4 \cdot 7H_2O$ ……0.25 g 蒸留水……1000 cc
 塩酸を以て pH 2.4 に調節。

酵母の場合には上記の培養液を 40 cc ずつ 4 個の 100 cc マイセル・フラスコに分注し、中 1 個は浸透価の測定に用いた。接種の方法は、一つは圧搾酵母そのままを 1 白金耳とった場合と、2 白金耳を 10 cc の水に懸濁し、これを 0.1 cc ずつ分注した場合とを試みた。30°C 恒温器中で培養し、24 時間毎に減量と浸透価を測定した。しょ糖を分離剤とし 20°C のスライド上で浸透圧の測定を出来る限り速に行った。酵母では原形質分離が直ちに起り、径が約 0.8 倍に縮まることが観察された。

次に、クロカビの場合は、上記の培養液を 80 cc ずつ 500 cc 振盪フラスコに分注し、2 白金耳の胞子を接種、14 日間 30°C で毎分約 110 回転で振盪し、測定のため毎日 3 個のフラスコを取除いた。浸透価の測定は酵母の場合と同様で、なるべく多量のしょ糖液をスライドに注ぎ、約 10 分後

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に $\times 1200$ 又は $\times 1500$ で検鏡した。滴定酸度, 残糖, 菌体重量, pH を Shu & Johnson⁽⁴⁾ の方法によって測定した。

なお, pH を変化させた実験には, 塩酸を用いた。

実験結果

原形質分離の形を Fig. 1 に示す。

1. 酵母のアルコール発酵と浸透価 Fig. 2 は接種量が多い場合の結果で, Fig. 3 は少ない場合のそれである。後者は, 5 日以後浸透価は一定せず大きな変動が見られたので, 図には最大値と最小値を示したが, 最小値は測定しにくいので確定的とはいえない。

2. クロカビのクエン酸発酵と浸透価 発酵期間中における糖消費率, 菌体重量, 生酸度, pH および浸透価の関係を Fig. 4 に示す。

3. pH との関係 塩酸を使って培養液の pH を変えて

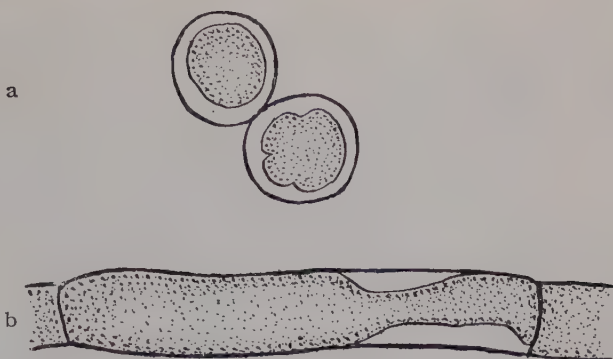


Fig. 1. Forms of plasmolysis
a. *Saccharomyces cerevisiae* b. *Aspergillus niger* $\times 1500$

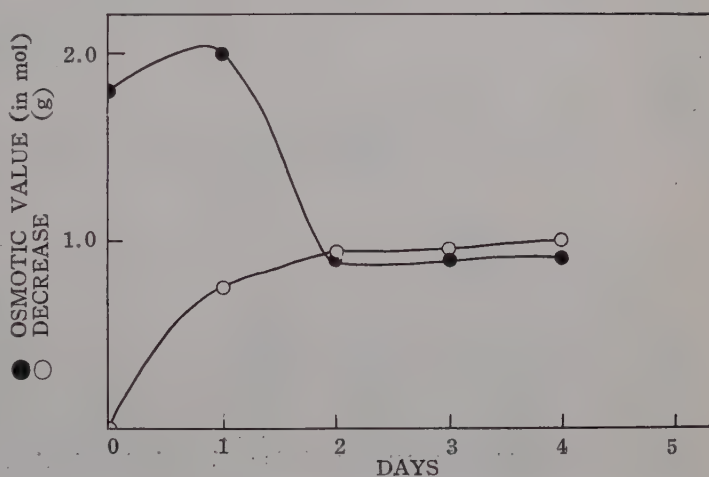


Fig. 2. Relation between the osmotic values and decreases of weight in *Saccharomyces cerevisiae*

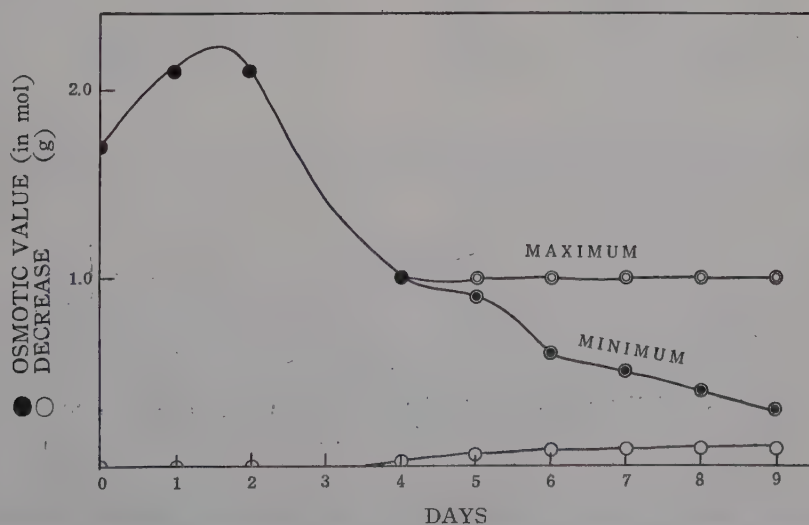


Fig. 3. Relation between the osmotic values and decreases of weight in *Saccharomyces cerevisiae*

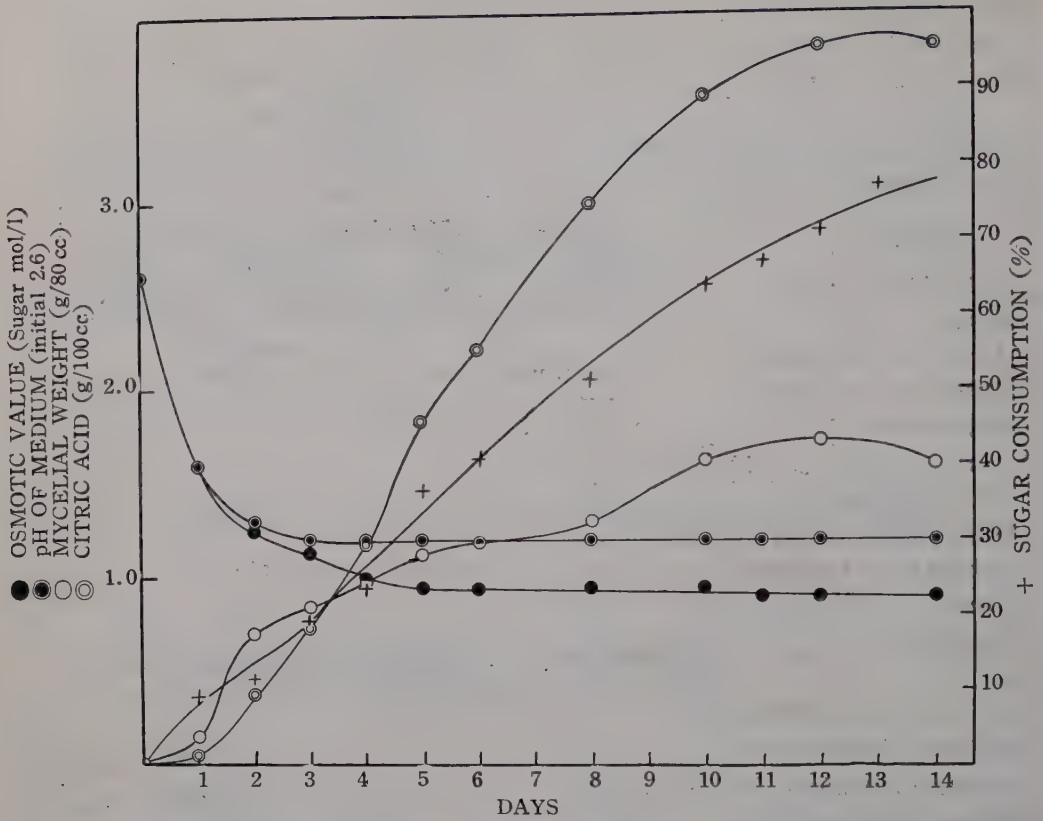


Fig. 4. Relation among the osmotic values, pH of the medium, mycelial weight, sugar consumption and the citric acid production in *Aspergillus niger*

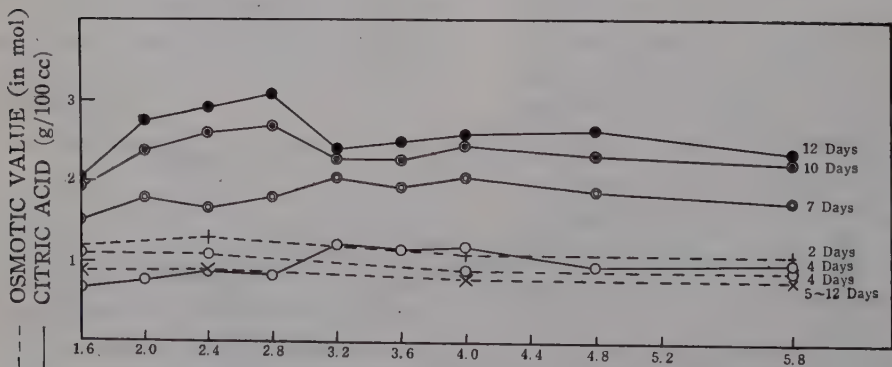


Fig. 5. Relation among pH, the osmotic values and the citric acid production in *Aspergillus niger*

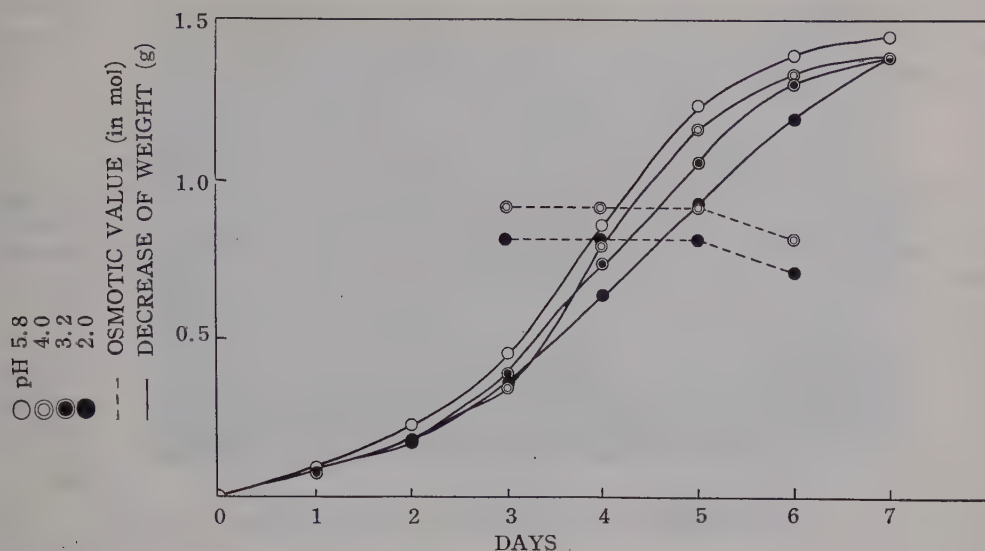


Fig. 6. Relation among pH, the osmotic values and decreases of weight in *Saccharomyces cerevisiae*.

実験してみるとクロカビの場合は Fig. 5 酵母の場合は Fig. 6 のようであった。

考察及び結論

上の実験によって、酵母とクロカビにおいては、相対的の浸透価は培養期間中著しい変動をすることが知られる。最初に Doegler & Prescott⁽²⁾ により、次いで Shu & Johnson⁽⁴⁾ によつて論じられたように、発酵期間中の化学変化は成長期と発酵期に分けられているが、予想されるように、成長期では浸透価は、養分を吸収して増加した後急激に減少している。この場合に、これらの値は浸透価の絶対的ではないにしても、*Atriplex confertifolia* の浸透価の 202.5 気圧⁽³⁾ に比べて大きな値であろう。

次に、この相対的の浸透価がしょ糖の 1 モル程度になると、発酵期が始まり、その期間中は殆んど一定している。クロカビの場合に、いろいろの濃度のしょ糖で培養してみると、クエン酸発酵が行われると否とに拘らず、発酵期の浸透価は最高値の約 0.6 倍程度のようなのである。

クロカビのクエン酸発酵の場合には、pH は 2.8 程度の低い値が、酵母のアルコール発酵の場合には、それより高い pH が最適であることが知られている。上の実験で知られるように、これらの最適の pH の場合に、浸透価の減少の割合が遅くなっていることは、興味がある事実と考えられる。

最後に、実験の便宜を与えられた武富教授、援助を頂いた川手氏その他の方々に感謝する。

Summary

In the present investigation, relations between fermentation and the osmotic pressure in *Aspergillus niger* and *Saccharomyces cerevisiae* were observed.

1. Though it is difficult to measure the accurate osmotic values, their relative values change in accordance with initial growth phases and fermentation phases, as were shown in the figures.
2. In *A. niger*, falling of the osmotic values is minimum and the citric acid production is maximum, when pH is low.

3. In *Saccharomyces*, on the contrary, high pH is preferable for the alcoholic fermentation. Falling of the osmotic values is minimum and the alcoholic production is maximum, when pH is higher.

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花粉の生理学的研究 XIII.

Camellia japonica の花粉管の伸長阻害について*

岩波洋造**

Yōzō IWANAMI**: Physiological Researches of Pollen XIII. Growth Inhibition of the Pollen Tube of *Camellia japonica*.

1956年12月26日受付

正常に伸び得る花粉管が、外的条件によってしばしばその伸長が害されることは、安田氏⁽¹⁾、Borriess⁽²⁾等、筆者⁽³⁾などによって観察されている。また筆者は別の実験⁽⁷⁾で、自花及び他種の花の柱頭と花粉との親和性を調べているが、この場合にも培養基上におかれた柱頭切片によって、花粉管の伸長が害されることが少くない。

花粉の新散布法

人工培養基上では、花粉管は一般に寒天板の面に沿って横に伸長を行うが、その際花粉管が曲折して伸びるばかりでなく、花粉のまかれ方によって発芽率、花粉管の伸長率を異にするのが普通である。(一般に花粉が沢山集ってまかれたものの方が少ないものよりも生長がよい。)このために花粉管の長さを測定するのが困難なばかりでなく、同じ実験においても、実験者によって異った結果を得ることが少くないと考えられる。そこで筆者は次

のような花粉の散布の仕方を考え、これを花粉管の伸長の阻害、促進などの実験に使用している。

カバーガラスの縁を使って、培養基上に花粉をほぼ均等の巾をもって一直線状に散布する。このようにしてまかれた花粉が発芽を行うと、花粉管は互に空間(他の花粉管のない場所)を求めて伸びるために、花粉粒が並んでいる直線に対してほぼ直角の方向にそろって伸長を行う。Fig. 1の写真がこれを示している。したがって花粉管の伸長度の観察に甚だ好都合であるばかりでなく、直線の一部に柱頭切片などをおくことによって、そのものが花粉管の伸長に及ぼす影響を明瞭に知り得る。

即ち Fig. 2のごとく、直線の一端が柱頭切片に接するようになっておくと、あるものは柱頭の近くの花粉管が長く伸び、あるものは逆に柱頭によって伸長が害され、管の先端の位置を線で結べばそのままグラフが形成される。なお筆者はこの方法を花粉管の誘導の実験にも応用している。

* 本研究は文部省科学研究助成金による

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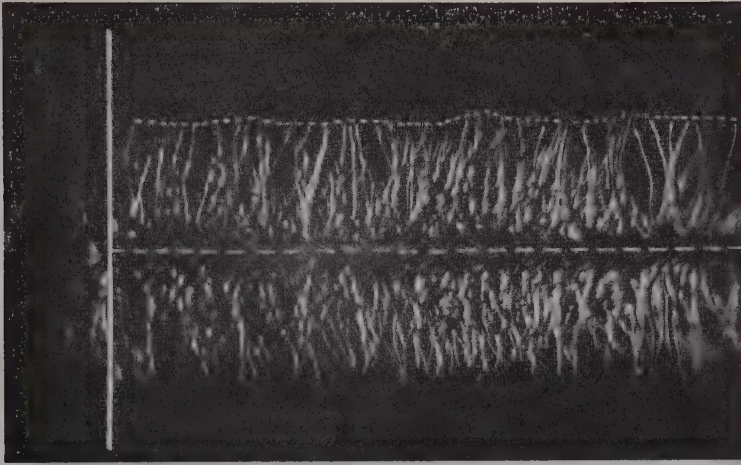


Fig. 1. 花粉を一直線状に散布した場合の花粉管の伸び方。
実線、破線、点線はあとで記入したもの。この中、破線的位置に花粉がまかれている。

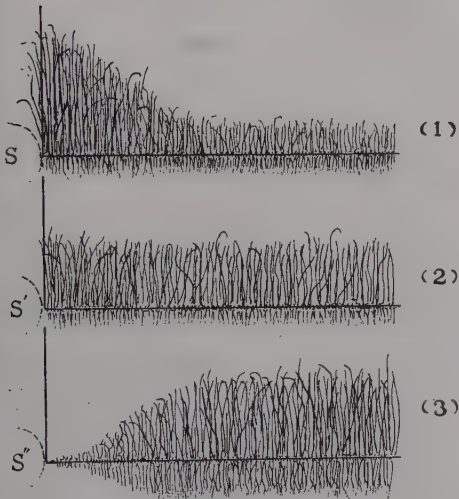


Fig. 2. 花粉管の伸長が柱頭組織によって受ける影響。

柱頭組織片 (S-S') に接して直線的に花粉をまくと、花粉管はほぼ直角の方向に伸長する (下半分の花粉管は略してある)。(1)—促進型 (Z 型), (2)—無影響型 (O 型), (3)—阻害型 (S 型)

実験 1

Lilium longiflorum Thunb. の柱頭の先端を、直径約 4 mm の大きさに切りとって、sucrose 10 %, agar 1.5 %, pH 6.5 の培養基の上にあげ、*Camellia* の花粉を上述の方法で柱頭切片の両側に散布した。Fig. 3 の装置で 21°C に保ちながら花粉管の伸長を観察した結果が Fig. 4 に示さ

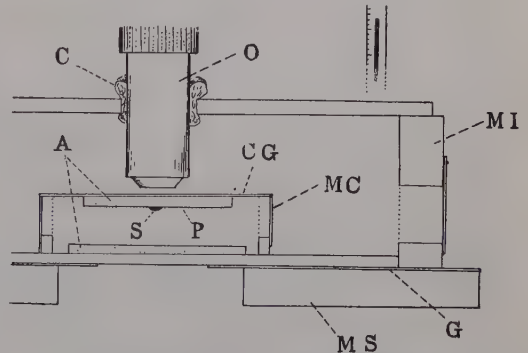


Fig. 3. 花粉管の伸長を観察する装置。
MI—顕微鏡、MC—湿室 (ガラス小箱)、CG—カバーガラス、A—寒天培養基、G—ゴム板、MS—鏡台、O—対物鏡、C—綿栓、S—柱頭切片、P—花粉

れている。I~IV は次のように熟度を異にする花の柱頭を用いた時のものである。

- I.....開花時の柱頭 (蕾の長さ 14 cm)
- II.....〃〃前日の柱頭 (〃〃12 cm)
- III.....〃〃3 日前の柱頭 (〃〃9 cm)
- IV.....〃〃5~6 日前の柱頭 (〃〃6 cm)

以上の結果から、培養基上におかれた *Lilium* の柱頭切片によって、花粉管の伸長が阻害されること、及びその阻害の度は、成熟した柱頭を用いた時ほど大となることがわかる。このように開花期に近づくに従って阻害力を増すことは、自家不和合現象における阻害作用と類似している。

Camellia の花粉管が *Lilium* の柱頭に対して S

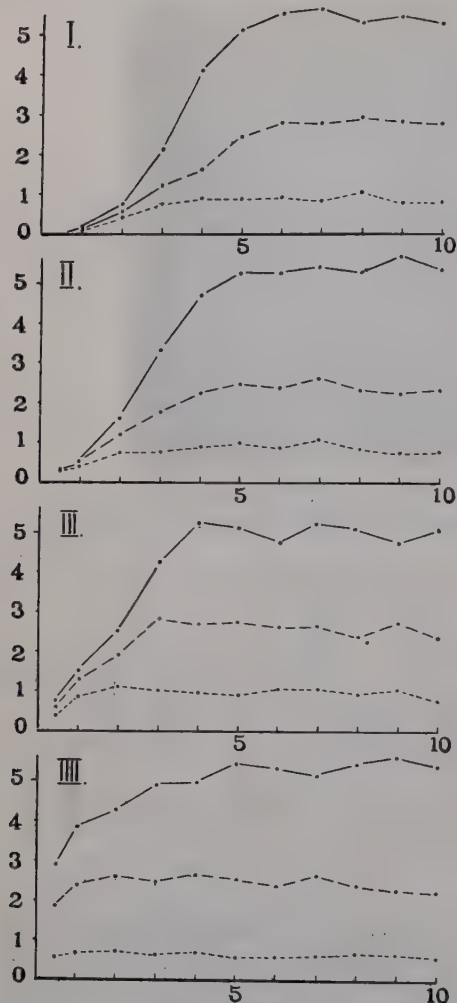


Fig. 4. *Lilium* の柱頭組織を近くにおくことよ
つて受ける *Camellia* の花粉管の伸長阻害。

I—開花時の柱頭, II—開花前日の柱頭, III—開
花3日前の柱頭, IV—開花5~6日前の柱頭, 縦
軸は花粉管の長さ, 横軸は柱頭からの距離(mm)。
..... 3時間後, --- 7時間後, — 20時間後

型, 即ち阻害型を示すことは, 一たん柱頭をおい
てからそれを取り除いた跡に対しても同様であ
り, 柱頭を熱したり (99°C で7分間), 柱頭の
組織汁を濾紙に興えてこれらを培養基上においた
場合にもみられるので, *Lilium* の柱頭から
Camellia の花粉の生長を害する物質が寒天板中
に拡散するものと考えて次の実験を行つた。

実 験 2

前記同様の培養基に, *Camellia japonica* の花

粉を約 2 cm の長さに直線的に散布し, Fig. 3
の装置で 21°C に保ちながら培養基の裏から花粉
管の伸長を鏡検し, 花粉管の長さが 1 mm 近くま
で伸びた時, 花粉管の先端から 0.5 mm 離して
Lilium longiflorum の柱頭切片をおいた。この
ようにしておくと, もし柱頭から花粉を害するよ
うな物質が出るとすると, 寒天中に拡散しながら
花粉に近づき, 一方の側においては最初に管の先
端部に相遇し, 他方の側においては, 先に花粉粒
の方に相遇する。

Fig. 5 は柱頭をおいてから 2 時間後, 4 時間
後, 及び 20 時間後の花粉管の伸長を示している。
このグラフから, 最も柱頭に近い位置にある花粉
管はすぐに伸長を停止し, 遠くにある花粉管ほど
長く伸びていることがわかる。また柱頭から 1.5
~2.0 mm の距離に花粉管の先端があるものは,
2 時間以前にすでに伸長を害されているが, 花粉
粒の位置がそれと同じ距離にあるものゝ花粉管
は, 2~3 時間を経過するも, まだ伸長を害され
ている様子がみられない。これは花粉の生長にお
いて, 外的な阻害作用に対しては, 先端部が基部
よりも敏感であることを示している。

花粉管の伸長が害される時に, 管の型が奇形的
に乱されることは, すでに安田氏⁽¹⁾, 筆者³⁾, 等
によって報告されているが, 細部にわたって調べ
られた研究はないようである。そこで *Camellia*
の花粉管が上述のように伸長を害される時, その
伸長速度の変化, 及び原形質流動の流速などにつ
いて観察を行つた。

実 験 3

花粉管が約 1 mm の長さに伸びた時, 寒天培
養基を裏返してカバーガラスに伏せ, 花粉の上部
近くに *Lilium* の柱頭切片をおいた。これを湿室
に入れてカバーガラスの面から花粉管の先端部を
観察した。

寒天板の裏に *Lilium* の柱頭組織を有する培養
基中で, 花粉管は次第に伸長を阻害され, 遂には
停止するに至るが, この間の1分間毎の管の伸び
を測定したものが Fig. 6 である。この中最下段
は柱頭切片から 1 cm 以上はなれていて正常に伸
長を行つているものについて調べたものである。
この図から正常に伸長するときは, 常に分速 1~
7 μ であるが, 次第に速度が落ちるとともに管の

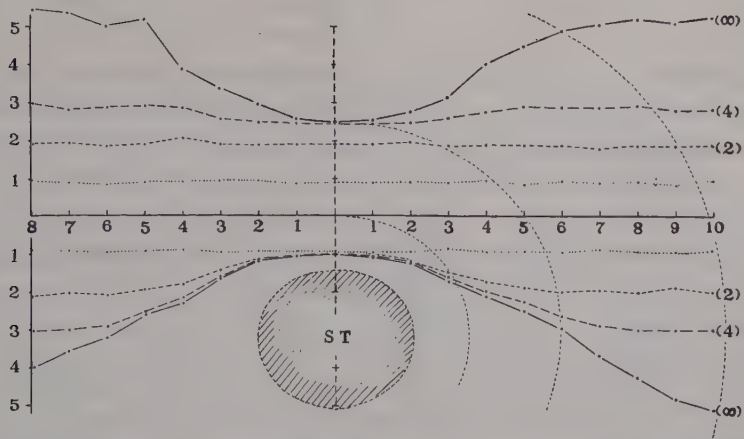


Fig. 5. 発芽後に *Lilium* の柱頭組織が近くにおかれた時の花粉管の伸長阻害。
ST—柱頭組織の位置 () 内の数字は柱頭をおいてからの時間 (h), 横軸は柱頭片に一番近い点からの距離, 縦軸は花粉管の長さ (mm)。

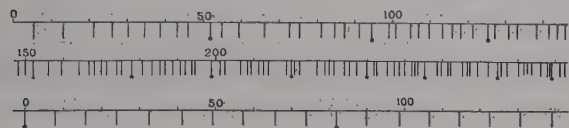


Fig. 6. *Lilium* の柱頭が近くにおかれた場合の花粉管(上二段)と正常に伸びている花粉管(下二段)との伸長速度の比較。1分毎の管の伸びを連続的に測定し、これを縦線で記入。数字は μ 黒点は 10分毎の管の伸びを示す。

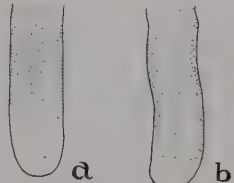


Fig. 7. 正常に伸びているもの (a) と伸長を害されつゝ伸びている花粉管 (b) との先端部の比較。

伸び方が間歇的となることを示している。即ち伸長がほとんど停止したかに見えた後、再び勢よく伸び始めることをくり返すが、この時帽体为中心部よりも左右何れかにずれて形成されることが多く、そのために花粉管は直線的には伸びないでいろいろの方向に向い、その結果、管が奇形化することくであった。Fig. 7 は正常な花粉管の先端部と、伸長を害されつゝ伸びているものとのを示している。透明にみえる部分が帽体である。

なお原形質流動については前述(4)(5)のごとく、花粉管の各部分で流速も流動の表現型もちがつているが、帽体の近くの花粉粒の方向に逆流する位置で測定すると、時間とともに流速は次第に落ちるが、花粉管が伸長を始めると流速も大となり、管が伸長を停めると流速も小となって一定していなかった。およそその変化を Fig. 6 の実験の途中で測ったものが表 1 である。なお花粉管の伸長が完全に停止してから後も、原形質の流動はかなり

長い間続いていた。これは花粉管の伸長の停止が、花粉の生死とは直接関係がないことの一例となるであろう。

柱頭をおいてからの時間 (min.)	流 速 (μ /min)
2	110
4	118
30—40	100—60
50—100	60—20
140—200	50—20

表 1. 伸長を害されつゝある花粉管内原形質流動の変化の一例 (*Camellia japonica*) 測定場所は原形質が管の先端部で逆流して基部に向う部分。

実 験 4

Lilium の柱頭内にある *Camellia* の花粉管の伸長を阻害するものが物質であることを確かめ、

その物質をクロマトグラフで調べる際に、およそどのくらいの移動率を示すかを知るために次の実験を行った。

1.9 mm の巾の濾紙 (東洋濾紙 No. 50) を 40 cm の長さのまゝ、ブタノール、エタノール、水 (4:1:1) の展開剤に下端を浸して一度頂上まであげ、20 時間乾燥させた後にこれを 11 cm の長さに切りとった。*Lilium longiflorum* の花の柱頭 2 ケを 1.0 cc の 80% アルコールの中ですりつぶし、遠心分離器にかけて得た上澄液を、濾紙の下端より 4 cm の所にガラスの細管で与えた。濃度をかえるために 1 度に約 0.03 cc づつ、12 回、6 回、3 回の 3 種類のもの、及び液を与えないものの 4 枚の濾紙を、上記の展開剤に浸して溶媒前線が着点より 5

cm の距離になった時に、濾紙をあげて 20 時間乾燥させた。その後に濾紙の中央部を 5 mm の巾に縦に切りとり、スライドガラスの上において、さらにその上に寒天板 (sucrose 10%, agar 1.5 %, pH 6.5) を静かに伏せて、上から花粉を実験 1 のように直線的にまいた。即ち濾紙の一部から *Camellia* の花粉の生長を阻害する物質が寒天板中に拡散すれば、その近くの花粉管の伸長が害されるようにしたものである。

22°C の湿室中で、20 時間経過した時に花粉管の長さを調べたものが Fig. 8 のグラフで示されている。I~IV は上述のとおり紙に与えた試料液の濃度のちがいを示し、この中 IV は試料液を与えずに展開剤に浸したときのものである。これらのグラフをみると、着点から 1~1.4 mm の部分と溶媒前線の近くの部分において花粉管の伸長が阻害され、さらにその中間の部分にも僅かではあるが他の部分よりも管の長さが短いところが見

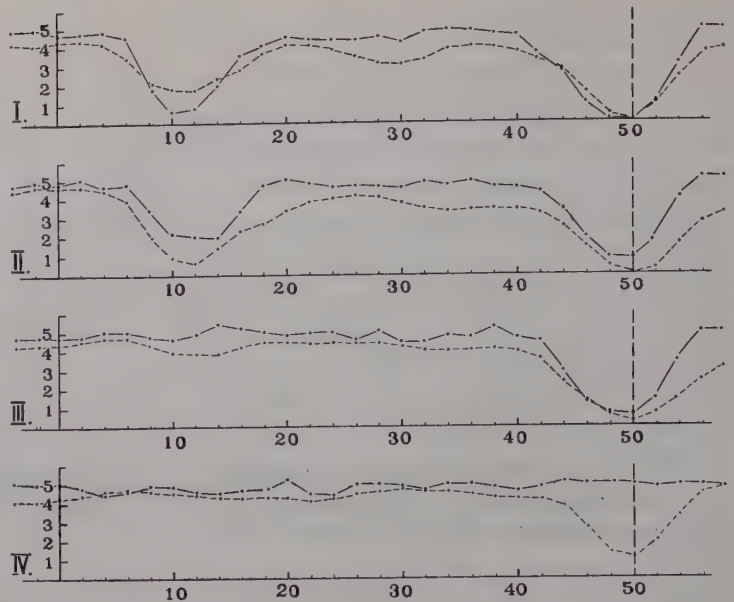


Fig. 8. *Lilium* の柱頭中にあつて *Camellia* の花粉の生長を阻害する物質の濾紙クロマトグラフ上の展開と、花粉管の伸長。I—III は濾紙につけた試料の濃度のちがひ (I は II の倍量, II は IV の倍量)。IV は展開剤だけを上昇させたもの。横軸は濾紙上の展開方向の長さ、縦軸は花粉管の長さ (mm)。

られる。たゞ溶媒前線の附近、即ち Rf が 1.0 に近いところの阻害は、しばしば試料液を与えないもの (IV) においても観察されたので、*Lilium* の柱頭に関係のない他の要素によるものと思われるが、このような場合にも試料液を与えたものは与えぬものに比してさらに阻害の度が大きいようであつた。しかしながら後二者に対しては更に検討を要するので、こゝでは、少くとも一つ以上の阻害作用をもつ物質があつて、その中の一つの物質の Rf が 0.2~0.25 である (ブタノール・エタノール・水) ことを報告しておく。これらの物質が培養基上で *Camellia* の花粉管の伸長を抑えたものと全く同一の物質であるかどうか? また三木氏⁶⁾らの研究している花粉管の誘導物質とどんな関係にあるか? などの問題について種々の方面から調査を続けている。

実験の一部に協力された会沢正義君に感謝の意を表する。

Summary

1) Elongating pollen tubes of *Camellia japonica* were checked by putting a slice of mature stigma of *Lilium longiflorum* on their culture plate. From this it is inferred that the stigma contains some substances which inhibit the growth of *Camellia* pollen tube and the quantity of these substances increases during the maturation of *Lilium* stigma (Fig. 3).

2) When *Camellia* pollen tube is affected in their growth, the tube elongation and protoplasmic streaming become intermittent, and the "Cap brock" frequently appears out of shifted from the centre of the tip of pollen tube (Fig. 5, 6).

3) The separation of the substances in the stigma of *Lilium* which can inhibit the growth of *Camellia* pollen was demonstrated by paper chromatography and pollen germination test. The Rf-value of one of these substances was found to be 0.2-0.25, using *n*-butanol, ethanol and water in a ratio of 4:1:1 as developer (Fig. 7).

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型を異にするトウモロコシ種子の多糖類生成に関する酵素学的研究* IV. 胚乳のフォスフォリラーゼ活性度の比較**

田 中 国 治***

Kuniji TANAKA***: Enzymatic Studies on the Mechanism of Polysaccharide Formation in Maize-Seed* IV Comparison of Phosphorylase Activity in Endosperm**.

1957 年 1 月 12 日受付

でんぷん質トウモロコシ (正常型) においては、胚乳中に形成される多糖類の大部分がでんぷんで

あり、その中約 28% のアミロースが含まれているのに対し、糖質においては多糖類の約 35% は水溶性多糖類として形成され、また糯質においては殆んど大部分がアミロペクチンである。そうした糖質及び糯質の胚乳における正常型とは異ったでんぷん形成の生化学的機構については、種々の考察がなされているが、実験的には未だ明らかにされていない。著者はその生成機構を明らかにす

* 文部省科学研究助成補助金による研究・課題番号 407075

** 本研究の要旨は日本生化学会 (1956. 11. 2) において発表した。

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るための一手段として、先⁽¹⁾にこれら 3 型のそれぞれの種子より得たフォスフォリラーゼについて、Primer 特異性を検したが、今回は交配後一定時期の胚乳について、胚乳 1 個当りのフォスフォリラーゼ活性度を測定し、品種間における差の有無を検した。材料としては、それぞれでんぷん質、糯質、糖質の種子、ならびにでんぷん質一糯質間、でんぷん質一糖質間の交雑種子を用いた。でんぷん質は糯質及び糖質に対してそれぞれ優性を示すことが知られているので、これら交雑種子の胚乳の酵素活性度は、でんぷん型のものと殆んど変わらないであろうことを期待した。

実 験 と 結 果

材料及び酵素活性度の測定

実験材料に用いた 3 型の品種は、Wisconsin No. 690 (でんぷん質)、Tokuto (糯質) 及び Country Gentleman (糖質) であった。測定は交配後 10, 15, 25 及び 35 日目の種子について行った。フォスフォリラーゼの活性度は、胚乳 1 個当りに含まれる酵素が、一定時間に一定条件でグルコース-1-りん酸より生ずる無機りん酸の量を求めて表した。測定用の酵素液としては、一定条件で胚乳を処理して得た酵素液を、そのまま精製せずに用いた。著者は本研究において酵素調製及び酵素活性度の測定を次の如く行った。ここに述べる条件は、成熟したでんぷん質トウモロコシ種子を用いた予備実験の結果に基いて定めたものであるが、酵素調製の開始より活性度測定開始までの時間中フォスフォリラーゼの顕著な失活は起こらず、またフォスファターゼ作用を除くために加

えたふつ化ソーダは、用いた濃度ではほとんどフォスフォリラーゼに影響せずに、フォスファターゼを完全に近く阻害した。

酵素調製

種子 25 粒をとり、胚、種皮及び珠心を取り除いた (交配後 25 及び 35 日目のものでは、珠心は胚乳に固着し、充分に取り去ることはできなかった)。種子は生長状態に変異があったので、交配後各時期における胚乳 1 個当りの平均生重量がでんぷん質のものと同程度になるように選択した。かくて得た胚乳を少量の石英砂と共に、0.01 M ベロナール塩酸緩衝液 (pH 9.0) 20 ml を除々に加えながら磨碎攪拌 (15 分間継続) して酵素を溶出させた。混合物を遠心分離 (3000 r. p. m. 15 分間) にかけて懸濁液をとった。残滓を 3 ~5 ml の上記緩衝液で洗滌し、遠心分離 (3000 r. p. m. 15 分間) にかけて得た洗滌液を先の懸濁液に加え、緩衝液を加えて全量 25 ml とした。酵素抽出操作の開始より、測定開始までの時間はすべて 1 時間であった。

酵素活性度の測定

酵素活性度測定のための反応混合液の組成は、0.1 M グルコース-1-りん酸カリ塩 1.0 ml, 0.07 M の NaF を含む 0.5 M クエン酸塩緩衝液 (pH 6.0) 0.5 ml, 2% 可溶性でんぷん 1.0 ml 及び酵素液 1.0 ml であった。反応温度 35°。上記酵素液 1 ml は胚乳 1 個の抽出液に相当する故に、この条件で 30 分間に反応混合液全量 3.5 ml 中に生成した無機りん酸量 (mg) で胚乳 1 個当りの酵素活性度をあらわした。

Table 1. Extraction of phosphorylase from the endosperms of starchy corn obtained 15 days after pollination.

Experimental No.	Fresh weight of endosperm (g)	Phosphorylase	
		activity per endosperm*	yield (%)
1	0.140	0.237	
2	0.128	0.244	96
2**		0.0076	4
2***		0	0

* Milligrams of inorganic phosphorus produced/3.5 ml of the reaction mixture under the conditions described in the text.

, * Preparations obtained, from the residues of preparations of 2 and 2** respectively, in the same way as described in the text.

Table 2. Phosphorylase activity of growing maize endosperm.

	Days after pollination	Strain						
		starchy	starchy × waxy	waxy × starchy	waxy	starchy × sugary	sugary × starchy	sugary
Fresh weight of endosperm (g)	10	0.032	0.048	0.044	0.044	0.048	0.044	0.048
	15	0.132	0.124	0.104	0.116	0.132	0.128	0.123
	25	0.220	0.208	0.200	0.200	0.204	0.212	0.204
	35	0.220	0.252	0.200	0.200	0.232	0.208	0.212
Phosphorylase activity per endosperm*	10	0.034	0.048	0.076	0.062	0.045	0.113	0.062
	15	0.244	0.288	0.275	0.310	0.261	0.363	0.251
	25	0.254	0.220	0.144	0.288	0.189	0.333	0.303
	35	0.140	0.113	0.041	0.048	0.172	0.130	0.199

* See Table 1.

著者は先⁽¹⁾の研究において、でんぷん質及び糯質種子のフォスフォリラーゼは、糖質の酵素と異って、可溶性でんぷんよりも糖質種子に形成される水溶性多糖類の一種グリコアミロースによってよく活性化されることを見出しているので、交配後一定時期（10 日及び 15 日）の胚乳について、Primer としてグリコアミロースを用いた場合の酵素活性度の比較も行った。

基質、緩衝液及び可溶性でんぷん液の混合液と、酵素液とを別々に 10 分間測定温度に保った後、酵素液を加えて混合した。反応時間 30 分後、10 %三塩化酢酸 2.5 ml を加えて混合し、酵素作用を停止させた。沈澱をろ紙で除き、ろ過液の一部をとって無機りん酸を測定した。別に反応開始時のものについて同様な測定を行い、両者の差をフォスフォリラーゼ作用により生じた無機りん酸として計算した。無機りん酸の測定は Fiske-Subbarow 法⁽²⁾により、光電比色計で行った。

こゝで用いた方法により、交配後 15 日目のでんぷん質トウモロコシの胚乳について測定した実験では、全酵素量の 96%が得られ、また Table 2 に掲げた結果をも含めて、3 個の別々の穂について得た値はよく一致した (Table 1)。

結 果

測定の結果を Table 2 に掲げた。表の上半部には用いた胚乳 1 個当りの生重量、下半部にはフォスフォリラーゼの活性度が掲げられてある。表にみられるように、用いた各品種の各々の時期における生重量は大体近い値を示すものであった。また各々の品種の酵素活性度は、交配後 15

乃至 25 日目のものが最高を示し、種子の生長に伴う活性度の消長は略同一の傾向を示した。この傾向は、糯質トウモロコシ種子についての Bliss 及び Naylor 等⁽³⁾ の得た結果と大体一致した。各期における 7 種の胚乳のそれぞれの活性度は多少の差違を示したが、測定期間を通じてみると互に著しい差はなかった。即ちでんぷん質が糖質及び糯質に対して高い活性度を示すという傾向は全く認められなかった。またでんぷん質と糯質及び糖質との交雑種子においても、糖質×でんぷん質に稍高いと思われる値を認めた外は、糖質及び糯質と略同程度の活性度であった。また Primer による活性度の差違は全然認められなかった。

考 察

以上の実験結果は、糖質及び糯質トウモロコシの胚乳 1 個当りのフォスフォリラーゼ活性度は、でんぷん質のそれと実質的にかわらないであろうことを示すものである。勿論生体内では、種々の細胞生理学的条件の違い、或は酵素阻害剤の有無等により、間接的に酵素作用が影響を受ける可能性もあり得るから、これらのことについて検討した上でなければ断定することはできないが、でんぷん質、糖質及び糯質トウモロコシの胚乳中にそれぞれ多少異った炭水化物が形成されるのは、おそらくフォスフォリラーゼの活性度の相違によるものではないであろう。したがってまた糖質の胚乳にはでんぷん質のそれに比較してフォスフォリラーゼがごく僅かしか含まれていないであろうという Harte⁽⁴⁾ の推測は妥当とは思われない。

論文のご高閲を賜った東京教育大学三輪知雄教授に対し厚く感謝の意を表する。また材料の栽培

は大阪学芸大学岡本義春助教授のご援助によった。こゝに深謝する。

Summary

The phosphorylase activity was determined with the growing endosperms of each of the starchy, waxy and sugary races of maize as well as those of the hybrids, starchy×waxy and starchy×sugary. Changes in the enzyme activity were followed during the period of from 10 to 35 days after pollination.

No appreciable difference was found to exist between these different races and also between the hybrids thereof.

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ミトリササゲの発芽初期における澱粉粒の消長*

(ミトリササゲにおける形態形成の研究 第I報)

川 松 重 信**

Sigenobu KAWAMATU**: Changes in the Distribution and the Amount of Starch Grains in the Seedlings of a Bean, *Vigna sesquipedalis**. (Morphogenetical Studies in *Vigna sesquipedalis*, 1.)

1957年1月14日受付

種子発芽に伴う諸物質の変移、消長及びそれと関連した物質代謝については、近來多くの報告がなされている。ミトリササゲについては、太田等(4, 10, 11, 12, 13, 14)によって生理化学的に広汎な研究がなされている。堀田(1954)は同じミトリササゲを用いて発芽初期の形態学的研究をしている。これらの諸結果から、発芽初期の生長

に炭水化物が一つの重要な役割をしていることが指摘される。

発芽に伴う炭水化物の動きを追究するのに、先ずでんぶんの消長が問題となる。筆者はミトリササゲ種子の発芽初期の各器官について、生長に伴うでんぶん粒の消長に関して若干の観察を行った。

この研究に當って、名古屋大学理学部生物学教室植物第一講座の人々から施設の利用など御援助をいただいたことを記し、感謝の意を表する。

材料と方法

材 料

* 本研究の一部は文部省科学研究費(総合研究課題番号 4074)を用いて行われた。この研究の一部は、日本植物学会中部支部大会(第3回)で発表した。

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市販のミトリササゲ *Vigna sesquipedalis* Wight の種子を用いた。発芽状態、生長状態をなるべく同じようにそろえるため前年産の種子を用いた。

観察時期

完熟乾燥種子そのものの観察を0時間とし、以後は水に浸してから5時間おきに5, 10, 15, 20, 25時間目に観察した。30, 35時間, 2, 3, 4, 5, 6, 7日目の発芽幼植物の場合には、最初の24時間は水に浸し、それから種皮をむいて培養したもので観察した。7日目で観察を打ち切った理由は、子葉は7日目で離脱し、以後は専ら自營的な生長しかなし得ないという一段階を劃する時期だからである。

培養方法

試験管に5ccのKnop液を入れ、細長く切ったろ紙を2枚立て、その間へ種皮をむいた24時間目の幼発芽植物をはさむ。この方法は幼根や胚軸をまっすぐに生長させるので、都合がよい。試験管は30°Cの暗黒にした恒温器へ入れた。Knop液及び暗黒ということで、発芽植物体の炭水化物は全く外部から入らず、すべて体内の変移・消長だけに問題が限られる。

観察した部位

幼根、子葉、子葉附着部位、ヒポコチル(胚軸)、エピコチル(上胚軸)及び幼葉(第一葉)。ヒポコチルは最も長く伸長し、かつ伸長度が一様でないで、上、中、下に区切ってそれぞれ観察した。またエピコチルも4日目頃から伸長度が大になるので、上下に分けて観察した。幼根では、根端部と根毛の生えている伸長部とに分けて観察した。

観察方法

上記の各時期の各器官を Tellyesniczky 液で固定し、パラフィン法で10 μ の切片とした。染色は主としてI₂KIを用い、補助的に Hotchkiss McManus 法及び Lillie 法のも糖類染色法を用いた。いずれの場合もでんぷん粒は赤紫色に染まる。生材料の徒手切片及び凍結切片も作り染色したが、固定パラフィン切片法と全く同一の結果であった。

観 察 結 果

(1) 子 葉

発芽と共に子葉中のでんぷん粒は次第に数が減少し、又形も次第に小さくなってゆく。0時間か

ら25時間までは、その変化は著しくない、即ち子葉内の柔細胞はすべて大きなでんぷん粒がぎっしりつまっている(Pl. IV, 1)。30時間目頃から、でんぷん粒の減少は著しくなり、それと共にI₂KIで黄褐色に染る小粒子が目立ってくる(Pl. IV, 2)。2日目頃には、子葉外辺部の細胞にはでんぷん粒は殆んど無くなる(Pl. IV, 3)。でんぷん粒の減少、消失は時間と共に子葉内部の細胞へと及んでゆく。4日目頃には維管束のまわりの柔細胞にしかでんぷん粒は見られない(Pl. IV, 4, 5)。更に時間がたつと、この部位のでんぷん粒も消失してゆき、7日目即ち子葉離脱の頃には維管束のまわりの細胞に僅かのでんぷん粒が残っている程度となる(Pl. IV, 6)。

(2) 子葉附着部位

この部分は、3~4日目頃から第二次的な細胞分裂を行い、離層形成が行われる特殊な機能を現す組織である。0時間の時から既に少量且つ小粒のでんぷん粒が見られる(Pl. IV, 7)。ところが24時間程たった頃にはでんぷん粒は全然見られない(Pl. IV, 8)。次に30時間目頃から急激にはっきりとでんぷん粒が出現し、次第にその数が増加し(Pl. IV, 9)、35時間~2日目頃に最高に達する(Pl. IV, 10)。しかし、その1粒の大きさは子葉のそれにくらべはるかに小さい。3~5日目にかけてでんぷん粒は離層形成部位に特に集中的に偏在してくる(Pl. IV, V, 13)。離層の分化形成は5日目には極めて明らかとなる(5~6日目に離層が出来て崩かいしてゆくことは、細胞形態学的観察のほかにもその部分がルテニウムレッドでよく染まることから確かめられた)(Pl. IV, 12)。6日目には離層細胞は崩かいし始め子葉離脱現象が始まるが、その頃には崩かい部の両側にでんぷん粒を含む細胞の列が見られる(Pl. IV, 14)。

(3) ヒポコチル

0時間の時に既にかなりの量のでんぷん粒が見られる。しかしその形は小さい(Pl. V, 1)。10~15時間目頃にはいく分増加の傾向を示すが(Pl. V, 2)、以後は次第に減少し25~30時間目頃になるとでんぷん粒は殆んど見られなくなる(Pl. V, 3)。この減少、消失期間を経たのちに再びでんぷん粒は出現し、しかも急激に増加し、35時間目頃にはでんぷん鞘(starch sheath)が現れ(Pl. V, 4)、2日目頃にヒポコチル全体のでんぷん粒の増

加は最高に達する (Pl. V, 5)。これ以後は、又次第に減少してゆくが、このさいでんぶん鞘の近くの細胞にはあとまででんぶん粒が残って見られる。この頃のヒポコチルはかなり長くなって居り、上、中、下の3部分ででんぶん粒の量は異なる、即ち下部ほど少い (Pl. V, 5, 6, 7)。更に時間がたち、5日目頃 (この頃はヒポコチルの生長は殆んど止まっている) になるとでんぶん粒は殆んど消失して居り、でんぶん鞘に僅かに見られるだけである (Pl. V, 8)。

(4) エピコチル

ヒポコチルによく似た結果を示す。0 時間のとき既にでんぶん粒は存在している (Pl. V, 9)。10~15 時間目頃いく分増加の傾向を示し (Pl. V, 10)、以後減少し 25~30 時間目頃にはほとんど消失し見られなくなる (Pl. V, 11)。しかるに又急激に増加し、2 日目頃に最高量のでんぶん粒が見られる (Pl. V, 12)。それ以後は次第に減少してゆく (Pl. V, 13)。4 日目よりはエピコチルもかなり長くなるので、上、下の2部分に分けてみると、5 日目までは下部の方が上部にくらべてでんぶん粒が多い (Pl. V, 14, 15)。しかし、6 日目以後は、逆に上部の方に多くなり、下部にはほとんど見られなくなる (Pl. V, 16, 17)。

(5) 幼 根

根端部 0 時間から発芽後 20 時間乃至 24 時間目までは、 I_2KI で僅かに青く染る微小粒しか見えず、典型的なでんぶん粒は存在しない。24 時間目頃から、はっきりしたでんぶん粒が黒く染って、根端生長点分裂部位に接した根冠のところ少し現れてくる。30 時間目には、更にはっきりとし、根端をつつむ根冠部にはどこでもでんぶん粒が見られる。2 日目に、でんぶん粒の出現度は最大となり、且つ、生長点分裂部位と根の最先端との間の円錐体状の部域に最も著しくでんぶん粒が分布して見られる (Pl. V, 18)。3 日目からは、でんぶん粒は減少しはじめ、5 日目には、ごく僅かしか見られず、7 日目には殆んど完全に消失してしまう。

伸長部 0~30 時間位の頃は、ヒポコチルとの区別が困難なので、2 日目以後即ち根毛が生じはじめた時から扱った。2 日目には、その部域全体にでんぶん粒が僅か見られる。3 日目も大体同様であるが、でんぶん鞘には特に多量のでんぶん粒

が見られる。4 日目以後は、その部域全体を通じてでんぶん粒は減少してゆく。特に中央部には殆んど見られなくなる。但しでんぶん鞘には最後 (7 日目) まで僅かではあるがでんぶん粒は残っている。

(6) 幼 葉

ミトリササグでは第一葉 (2 枚の幼葉 plumule) は、既に完熟種子内において形成されている (但し、柵状・海綿の面組織分化は未だ行われていない)。0~20 時間の頃には、中肋部の下面に当る部域にのみ極めて僅かではあるがでんぶん粒が見られる。30 時間目には、増加し、出現部域も中肋下面部を中心に左右の葉肉下側部に及ぶ。2 日目には、でんぶん粒は極めて顕著となり、部域は葉肉上側部にも見られる (Pl. V, 19)。3 日目からは、でんぶん粒は減少しはじめ、中肋下面にだけ僅か残った状態で 7 日目にいたる。

考 察

用いた培養方法即ち暗処で Knop 液という条件では、ミトリササグの発芽幼植物は炭素源に関する限り従属栄養的な生長を行っていると思なしてよい。即ち発芽開始時の種子の各期官、組織内にある炭水化合物が、発芽生長とともに変化するだけである。或るものは呼吸基質として消費され、或るものは相互に転化し合ってゆく (でんぶん可溶性糖とセルロース)。これらに関する生理化学的解析はミトリササグにおいて太田 (1953, 1954), Oota, Fujii & Osawa (1953), Oota, Fujii & Sunobe (1956), 藤井 (1956) により詳しく行われている。

植物体の個々の器官や組織におけるでんぶん粒の消長については古くから多くの研究があるが、近來は glucose-1-phosphate との関係においてなされている (Yin & Sun, 1949, Dyar, 1950, Ono, 1955 など)。しかし植物体の発生過程を追って各器官、組織のでんぶん粒消長をしらべた報告は少い (Buell, 1952 は *Dianthus* の胚囊・胚形成過程で詳しく観察している。原田 (1953) はミトリササグの胚形成の研究で、極めて簡単ではあるが、子葉におけるでんぶん粒蓄積の様子を見ている)。

筆者は本報において、ミトリササグの発芽初期の各器官、組織におけるでんぶん粒の消長を時間

を追って I_2KI 染色法でしらべた。ここにいう発芽初期とは、種子が発芽始めてから7日までの間であり、7日目という時期は、(1) 明処、暗処、栄養物の有無に関せず必ず子葉の離脱が起る時であり (堀田, 1954 及び未発表論文), (2) ここに用いた培養法では体内の物質の移動, 組み換えが一応終る時であり (Oota等, 1953), 又 (3) 同じくこの培養法では、種子内に形成されていた諸器官が展開しつづいた時であり、根毛の発生, 幼根内部組織の分化, 幼葉葉組織の分化及び子葉離層の分化は起るけれども太田 (1953) の言う「本質的には、すでに分化ずみの胚の各器官の拡大再生産にすぎず、新しい形態の展開すなわち茎の頂端部における葉原始体などの展開を実際上ともなわないといってよい」時であり、器官的オーダーでは単なる引き伸しとも言える簡単な生長が終った時である。要するに問題は専ら、子葉内に貯えられていたでんぷん粒が他の器官の展開に伴っていかに移動し消費されていくかということである。

観察結果を概観するために、Buell (1952) の用いた方法にならって、各器官、組織のでんぷん粒の消長を比較上の傾向として示すと第1図の如くである。でんぷん粒の減少は、形態学的には粒の数及び大きさの減少として認められるのであるが、問題は粒が微小になるにつれ、 I_2KI 染色の色調が変化することである。 I_2KI 反応は顕微化学的染色反応としては簡便且つ高い信頼度あるものとされているが、でんぷん粒が微小になると問題が出てくる (Swanson, 1948 は大きさと I_2KI 染色色調のことを論じている)。このミトリササゲの場合、赤褐色に染る小粒までにとどめ、それ以下の黄色に見える微小粒は問題外とした。

子葉には初め圧倒的に多量なでんぷん粒があり、発芽とともに一方的に減少してゆく。このことは Oota 等, (1953) の行つた可溶性多糖類 (主としてでんぷん) の定量的結果と一致している。但し、筆者の場合、発芽後1日間はでんぷん粒の減少は著しくない。これは、種子を水に浸したまま即ち aeration のない状態で発芽させたため、でんぷん分解が始んど起らないためであろうと考えられる。子葉におけるでんぷん粒消長において

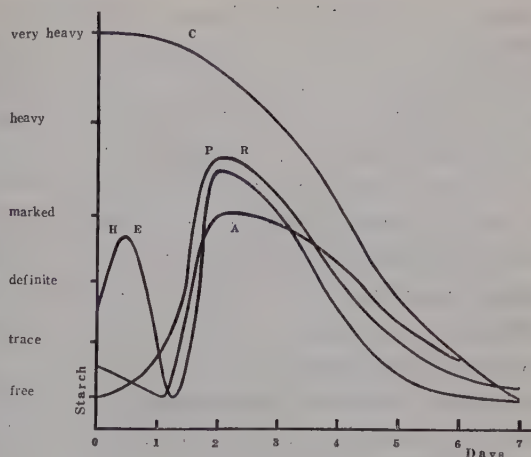


Fig. 1. Approximate tendency in changes of the amount of starch grains (after the representation mode employed by Buell, 1952). C: cotyledon, H: hypocotyl, E: epicotyl, R: radicle, P: plumule, A: abscission region of the cotyledon.

特に指摘したいことは、消失は子葉外辺部から始まり、次第に内部に及び、最後は維管束周辺の細胞にしかでんぷん粒が見られないことである。これは次のように説明できよう: (1) ミトリササゲの子葉内ででんぷんの可溶性糖類への分解は amylase によらず専ら phosphorylase によるものと考えられて居る (藤井, 1956)。でんぷん粒の減少・消失が外辺部から起るのは、phosphorylase の活動が酸素供給に関連して起ること即ち子葉組織の aeration は外辺部から順次内部へと及ぶからであろう。でんぷんからの糖生成に酸素の存在が大いに関係することは Porter, (1953), Porter & May, (1955), Oota 等, (1956) によって指摘されている; (2) 末期には維管束周辺の細胞にしかでんぷん粒が見られぬことは、その細胞の活動力、この場合維管束へ物を送り込む働き、と関連したと考えられる (後述の子葉離層部; 幼葉中肋附近、でんぷん鞘における場合も同じことであろう)。

子葉の離脱は新たにコルク形成層が分化し典型的な離層組織を作って行われる。形成層分化の開始は発芽後5日目の終り頃に始めて組織学的に認められる (堀田, 1954 及び未発表論文と一致した結果である)。しかるに離層形成予定域におけるでんぷん粒の消長は初期から特徴的な様子を示し

ている。即ち、発芽時に少量あったでんぷん粒は発芽とともに減少してゆき、24 時間程のうちには一旦全く見られなくなり、それからつづいて短時間のうちに急激にでんぷん粒は再び出現し、35 時間～2 日目に最高度になり、以後は漸次減少してゆく。組織学的に認められる離層の分化開始(5 日目)に先立って離層予定域にでんぷん粒の蓄積が起る(35 時間目から)ことは注意すべきことと思われる。離層組織の分化には、細胞分裂、セルローズ膜形成、ペクチン質の変化、コルク質の生成という一連の現象が短時日のうちにつづいて起っているのであり、離層予定域の細胞には当然、生理学的・生化学的变化が生じているわけである(堀田、(未発表論文)は若干の物質について組織化学的研究を行って、このことを裏づけている)。でんぷん粒の蓄積が早くも 35 時間目から著しいことは、離層予定域の細胞が既にその頃から活動を始めたことの一つの現れであろう。黒上・曾我部(1952)は、晩生柑橘八朔種のがく部離層細胞において同じくでんぷん様顆粒の沈積を見ており、このことは「単なる生理現象の一環であるか又はがく部分離の前駆的不可欠条件として発現せるものであるか否か現在のところ不明である。しかしとにかくかかる顆粒細胞が他の細胞に比し相当高い生活機能を維持していることは明瞭である。」と論じている。

ヒポコチルとエピコチルにおけるでんぷん粒消長は大体同じ傾向である。極めて初期(10～15 時間)にはほんの僅か増加を示す(他の器官、組織ではこのようなことは見られなかった)が、その理由は今のところ判らない。25～30 時間の頃に完全にでんぷん粒が消失するのは、ヒポコチル、エピコチルの生長活動に消費されたことと考えられる。しかも子葉から供給される糖の量が未だ少いことも相まっているであろう。2日目頃に最高度のでんぷん蓄積が見られるのは、その頃には子葉からの糖供給が充分になり、余分の糖がでんぷんとして貯えられたものと考えられる。その後は、次第にでんぷん粒は減少するが、このことは発芽後半期のヒポコチル、エピコチルの生長には前半期にくらべて多量の炭水化物が消費されることを示すものであろう。これは、太田(12)の「前半には原

形質たんぱく増殖と壁物質増殖が見られ、後半には壁物質増殖だけが独走する」という結論とよく一致している。なお、ヒポコチルでは上部の方が下部よりも常にでんぷん粒が多いが、エピコチルでは初めは下部に多く後に逆転して上部の方になる。このことは、ヒポコチルとエピコチルでは伸長領域の分布が異っていること及び「前半にヒポコチルで起ったことが後半にはエピコチルでくりかえされるもののようである」ということ(太田, 1953)から理解されよう。

幼根においては、根端部と伸長部ででんぷん粒の分布領域が異っている。根端ではでんぷん粒は根冠細胞にしか見られない(Dyar, 1950 の用いたマメにおいても、常に根冠細胞はでんぷん粒蓄積の能力が高い)。2 日目までに急速に蓄積が起り、以後は次第に減少しているが、これはここに用いた培養法では根端の生長は発芽前半で大体停止し、以後はむしろ凋びてゆくこと、即ち生長活動の程度と対応して説明できることであろう。幼根の伸長領域ではでんぷん粒は専らでんぷん鞘に見られる(ヒポコチルにおいてもでんぷん鞘にでんぷん粒の蓄積が最後まで認められた)。でんぷん鞘の生理学的役割とでんぷん粒の消長については、この場合、はっきりした説明はできないが、やはりこの部分の細胞は特別な活動をするものと見なされているから(Haberlandt, 1918, Esau, 1953)、単なるでんぷんの貯蔵場処というほかに内皮の分化と関連する積極的な役割も考えられる。

幼葉に関しては、中肋周辺の細胞に常にでんぷんの蓄積が強くみられることを指摘したい。これは子葉における場合と同じく、該細胞の有する活動力と結びついた現象として理解されよう。

以上の、子葉、子葉附着部位(若しくは離層形成部)、ヒポコチル、エピコチル、幼根、幼葉におけるでんぷん粒の分布、消長の状態を通じて、次のことが一貫した現象として指摘し得るであろう：(1) でんぷん粒は子葉から他の器官、組織へと移ってゆき、(2) そこにおけるでんぷん粒の消長は、子葉から供給される量とそこで消費される量との差として現れていること、及び(3) 生長活動特に細胞の活動が盛んな組織又は近隣の組織にでんぷん粒の蓄積が強いこと、である。

Summary

1. Changes in the distribution and the amount of starch grains were observed following the development of various organs and tissues in young seedlings of a bean, *Vigna sesquipedalis*.

2. The amount of starch grains in the cotyledon decreases steadily as germination proceeds; after 24 hr. the decrease is especially abrupt. Starch grains are first consumed in the outer portion of the cotyledon and the consumption proceeds then inward, and finally, on the 7th day, starch grains are observable only in the cells around the vascular bundles.

3. In the presumptive abscission region of the cotyledon, there is a marked accumulation of starch grains from the 2nd to the 5th day; on the 5th day the inception of a histologically detectable differentiation of abscission layer of the cotyledon appears.

4. The hypocotyl and the epicotyl possess a definite amount of starch grains at the beginning of germination; from 25 to 30 hr. the amount of starch grains becomes minimum; soon after they increase again and on the 2nd day their amount reaches maximum; then they decrease gradually until the starch grains are almost all consumed on the 6th day, except for a few remaining in the starch sheath of the hypocotyl.

5. In the radicle, there is a heavy accumulation of starch grains in the root cap cells and markedly so in the starch sheath of the elongation zone, reaching a maximum on the 2nd day.

6. In the plumule, starch grains are first detectable only in the dorsal part adjacent to the midrib; on the 2nd day they locate throughout the dorsal mesophyll tissue and then they decrease gradually until on the 6th or 7th day a few starch grains are retained only in the cells beneath the midrib.

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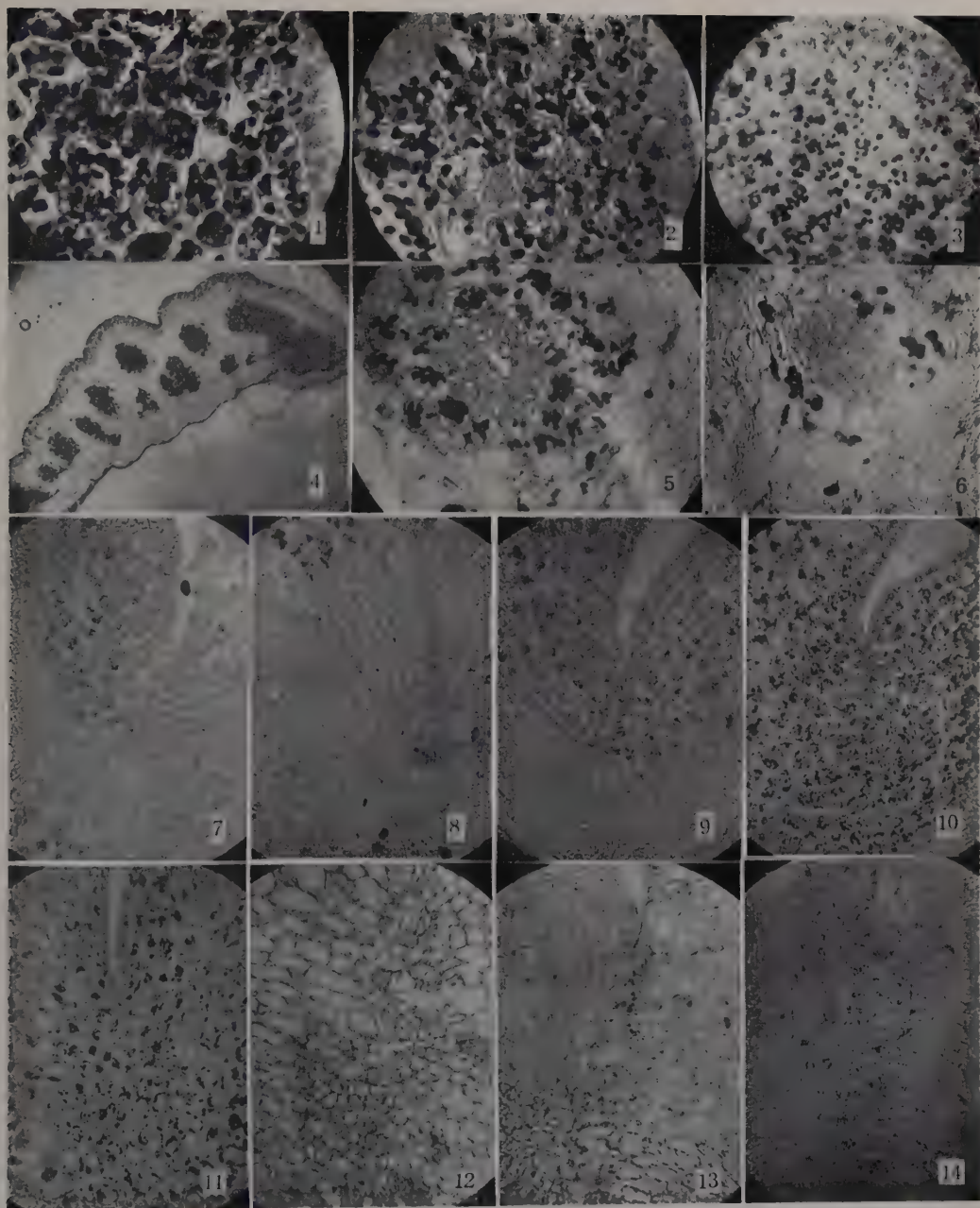


Plate IV. 1—6. Starch grains of the cotyledon at various times after germination. ca. $\times 90$, except for 4 (ca. $\times 10$). 1. 24 hr. 2. 30 hr. 3. 2 days. 4. 4 days. Cross section, showing several vascular bundles. 5. 4 days. One vascular bundle. 6. 7 days. Ditto.

7—14. Starch grains in the abscission region of the cotyledon. ca. $\times 90$. 7. At the beginning of germination. 8. 24 hr. No starch grains. 9. 30 hr. 10. 35 hr. 11. 3 days. 12. 5 days. Formation of the abscission layer (iron haematoxylin). 13. 5 days. Ditto (I_2KI). 14. 6 days. Separating of the abscission layer.

S. Kawamura: Changes in the distribution and the amount of starch grains in the seedlings of a bean, *Vigna sesquipedalis*.

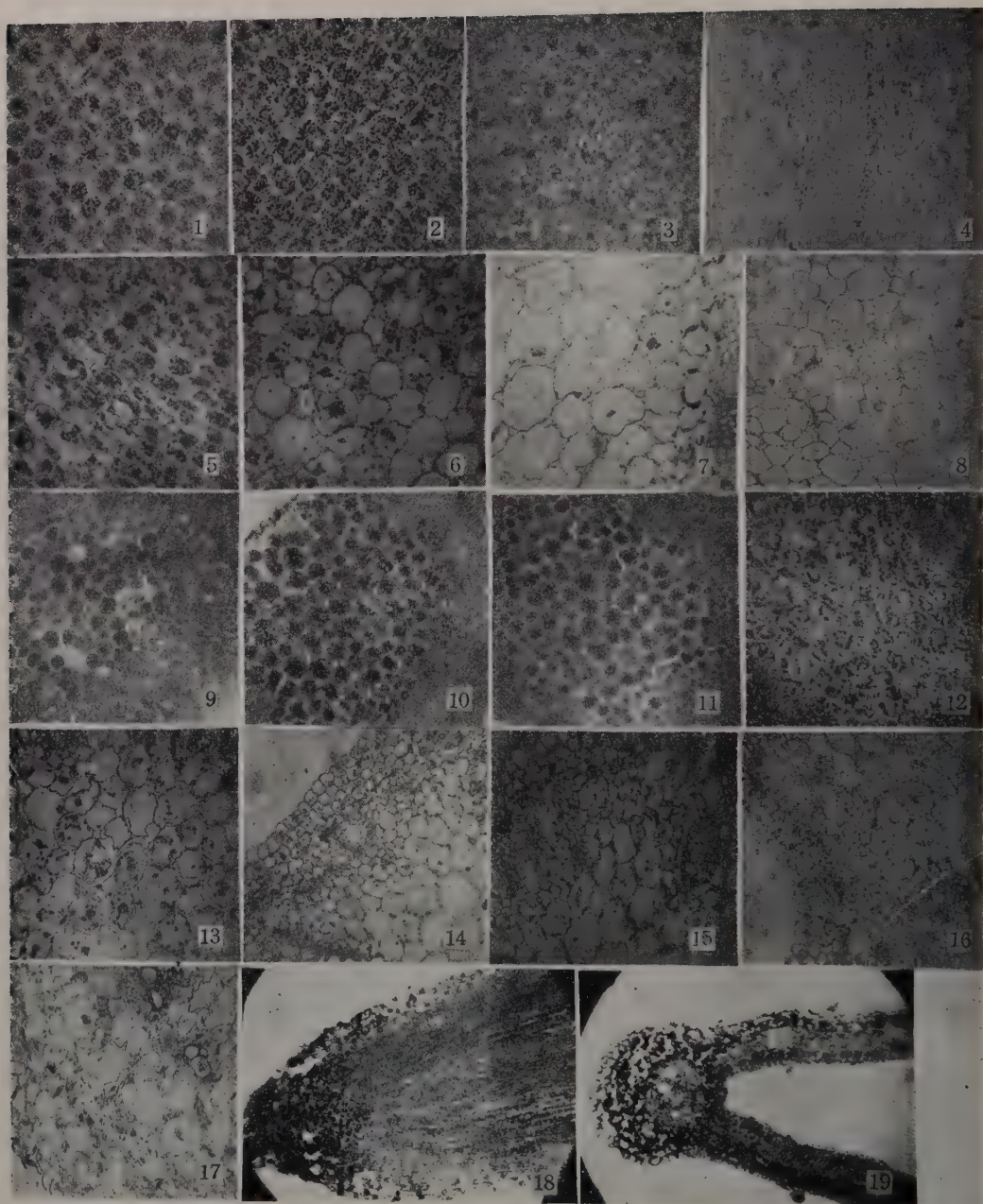


Plate V. 1—8. Starch grains in the hypocotyl. ca. $\times 90$. 1. At the beginning of germination. 2. 10 hr. 3. 30 hr. 4. 35 hr. Formation of the starch sheath. 5. 2 days. Upper part. 6. 2 days. Middle part. 7. 2 days. Lower part. 8. 5 days. Upper part.

9—17. Starch grains in the epicotyl. ca. $\times 90$. 9. At the beginning of germination. 10. 10 hr. 11. 30 hr. 12. 2 days. 13. 3 days. 14. 4 days. Upper part. 15. 4 days. Lower part. 16. 6 days. Upper part. 17. 6 days. Lower part.

18. Starch grains in the tip of radicle. 2 days. Starch grains are heavily seen in the root cap cells. ca. $\times 55$.

19. Starch grains in the plumule. 2 days. ca. $\times 55$.

S. Kawamura: Changes in the distribution and the amount of starch grains in the seedlings of a bean, *Vigna sesquipedalis*.

Starch Formation in Storage Organs V. Changes in Phosphorylase Activities during the Development of Potato Tubers

by Shichiro HORI*

堀 七郎*: 貯蔵器官内における澱粉の形成 (第五報) 馬鈴薯塊茎の生長間
におけるフォスフォリラーゼの変化

Received January 23, 1957

A number of studies have been made about the phosphorylase activities in potato tubers by several workers. Nakamura et al. (1951) studied quantitatively the amount of phosphorylase activity in mature potato tubers. Tagawa et al. (1954) studied the variation in the activity of this enzyme in potato tubers during the storage period. The writer investigated the histological distribution of phosphorylase in potato tuber (1954).

The present paper is concerned with a study of the changes in phosphorylase activities in potato tubers during the period from the beginning of the tuber formation till its full ripening.

Materials and Methods

Materials employed in this study were fresh potato tubers (race "Benimaru"), which were brought to use soon after the harvest from the field.

The enzyme activities were measured on the one hand with the entire tubers of different degrees of growth with the weight between 1 and 150 g, and on the other hand with tissue portions of the "medulla" and those of the cortex with buds separately. "Medulla" is the tissue portions inside of the vascular ring and "cortex with buds" is the external layers (ca. 1 cm in thickness) of the tissue surrounding buds.

For the preparation of the enzyme solutions from small tubers, samples with nearly the same weight were combined.

(1) Preparation of the enzyme solutions.

The preparation was carried out by a modified method of Nakamura et al. (1951) as follows:

Immediately after the tubers were harvested from the field, they were washed cleanly with water and then weighed. Each 30 g of the samples was ground well in a porcelain mortar. It was kept overnight in a refrigerator at 5°C under toluene. Next day it was pressed in cotton gauze and 14 ml. of pressed juice was obtained.

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It was centrifuged and the supernatant fluid was employed as the enzyme solution, which was diluted with water when desired.

(2) Determination of the enzyme activity.

The activity of the enzyme was determined by the modified methods of Green and Stumpf (1942), Hidy and Day (1945) and Nakamura et al. (1951) as follows:

In an about 10 ml. containing test tube, 0.5 ml. of 0.5 M acetate buffer (pH 6.0), 0.5 ml. of 5 per cent soluble starch, and 1.0 ml. of properly diluted enzyme solution which liberates not more than 0.5 mg of inorganic phosphorus for 10 minutes were introduced. Below this range of enzyme concentration the reaction rate is directly proportional to the amount of the enzyme applied. With distilled water the mixture was made to 2.5 ml. and kept at 38°C. After temperature equilibration the enzyme reaction was started by adding 1.0 ml. of 0.1 M glucose-1-phosphate which had been previously warmed at this temperature.

After periods of 0, 5, and 10 minutes, 1.0 ml. of the digest was withdrawn and 5.0 ml. of 6 per cent trichloroacetic acid was added. The mixture was shaken and filtered. With these filtrates the amount of liberated inorganic phosphate was determined colorimetrically by the method of Allen (1940).

The amount of the enzyme which under the conditions described above splits off 0.1 mg of inorganic phosphorus in 3 minutes was taken as the unit of the enzyme. Glucose-1-phosphate employed was a crystalline dipotassium salt prepared by the method of Sumner and Somers (1947).

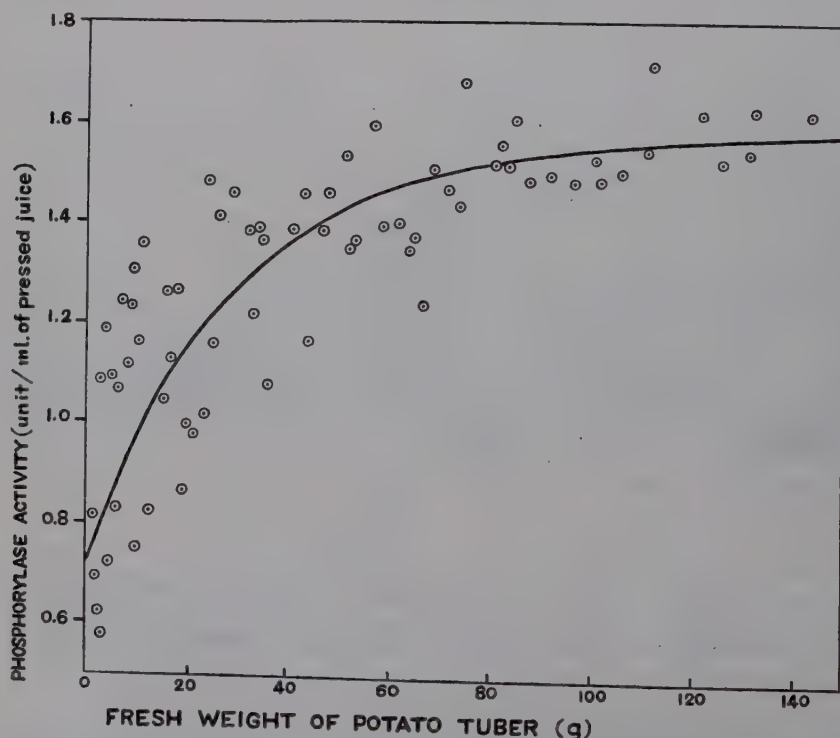


Fig. 1. Change in phosphorylase activity with growth of potato tubers.

Results and Discussion

The amounts of phosphorylase in the entire potato tubers of different weights from 1 to 150 g are given graphically in Fig. 1.

As can be seen in Fig. 1 the amount of phosphorylase of the tuber increased rapidly from the start of growth until it attained about 50 g in weight. Thereafter the rate of the increase gradually diminished and eventually no significant increase could be observed after the tuber had grown above 100 g. Thus it appears that the development of phosphorylase in the potato tuber proceeds nearly parallel to the increase of the tuber weight as long as the tuber is immature, although the enzyme activity fluctuated more or less considerably among tubers of the same weight.

Fig. 2 represents of the estimation of phosphorylase in "cortex with buds" and in "medulla" parts during the course of the tuber growth.

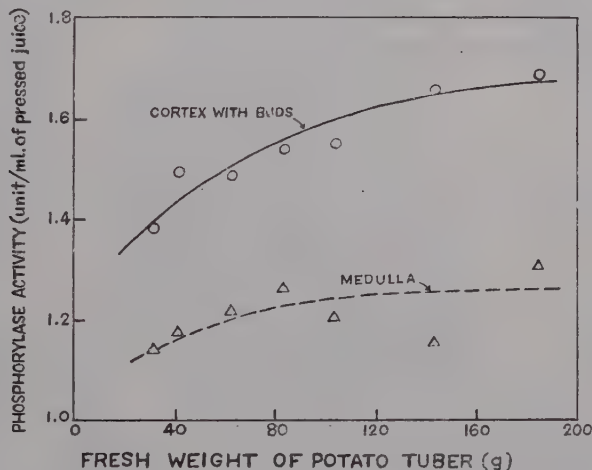


Fig. 2. Phosphorylase activities in two different parts of potato tuber ("cortex with buds" and "medulla") in various stages of growth.

The figure indicates that the "medulla" of the tuber exhibited lower activity of phosphorylase than "cortex with buds". Moreover it appears likely that the increase of phosphorylase as observed in the development of the whole tuber (Fig. 1) may be due mainly to that in the "cortex with buds". However, in the "medulla" also a slight increase in activity has been recognized with the tuber development. These findings may well be in accord with the previous observation that the amount of phosphorylase increases in the following order: medulla-cortex-bud (Hori, 1954).

Summary

The phosphorylase content of potato tubers was measured in the course of their development.

It was found that the amount of phosphorylase increased rapidly with the development of the tuber until the tuber grew to about 50 g in weight. Thereafter the

increase in enzyme content dropped gradually and nearly ceased when the tuber attained the weight of about 100 g.

It became probable that the increase in enzyme activity might be attributed chiefly to that in the "cortex with buds".

Sincere appreciation is expressed to Prof. T. Miwa, of the Tokyo University of Education, for his valuable advice and criticism during the course of this investigation and in preparation of this manuscript.

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Seed Formation of *Ellisiophyllum pinnatum* var. *reptans*.^{**}

by Takasi YAMAZAKI*

山崎 敬*: キクガラクサの種子形成

Received January 30, 1957

Material and methods: The process of the seed formation was studied in *Ellisiophyllum pinnatum* Makino var. *reptans* (Maxim.) Yamazaki of Scrophulariaceae collected from Hunakosiyama, Harima and Koetuyama, Awa in Japan by Mr. K. Utiumi and Mr. E. Akamatu who very kindly passed it to me for investigation. Formalin-acetic alcohol fluid was used for fixation. The sections were cut at a thickness 10-15 microns and stained with Heidenhain's iron-alum-haematoxylin.

Ovule and embryo sac. The ovary is, as common in other Scrophulariaceae, bilocular and has axial placentation with 6-8 anatropous ovules (Fig. 1 and 2). The mature ovule is hemispheric and has a single integument being made up of 13-14 layers of cells on the outside. A hypodermal archesporial cell divides giving rise to a linear tetrad of four megaspores. The chalazal megaspore functions and gives rise to the embryo sac (Fig. 3). In this stage the nucellar cells become flattened and are completely destroyed when the embryo sac matures. The innermost layer of the integument constructs the endothelium with the quadrilateral cells containing

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** This study was defrayed by the Scientific Research Fund of Ministry of Education.

prominent nucleus and dense cytoplasm. The endothelium invests the embryo sac partially, the antipodal and the micropylar ends are free (Fig. 4). In the early stage of the embryo sac formation, the integumental cells of chalazal part contain large nuclei and dense cytoplasm, and become nutritive tissue (Fig. 4). After the fertilization, these cells are lost their contents, and their wall thickens, thus the hypostatical tissue is formed (Fig. 5). The mature embryo sac is spatulate in shape and is formed of two portions being the broad globular micropylar and the elongated chalazal ones. Three antipodal cells lie side by side immediately disintegrate after fertilization.

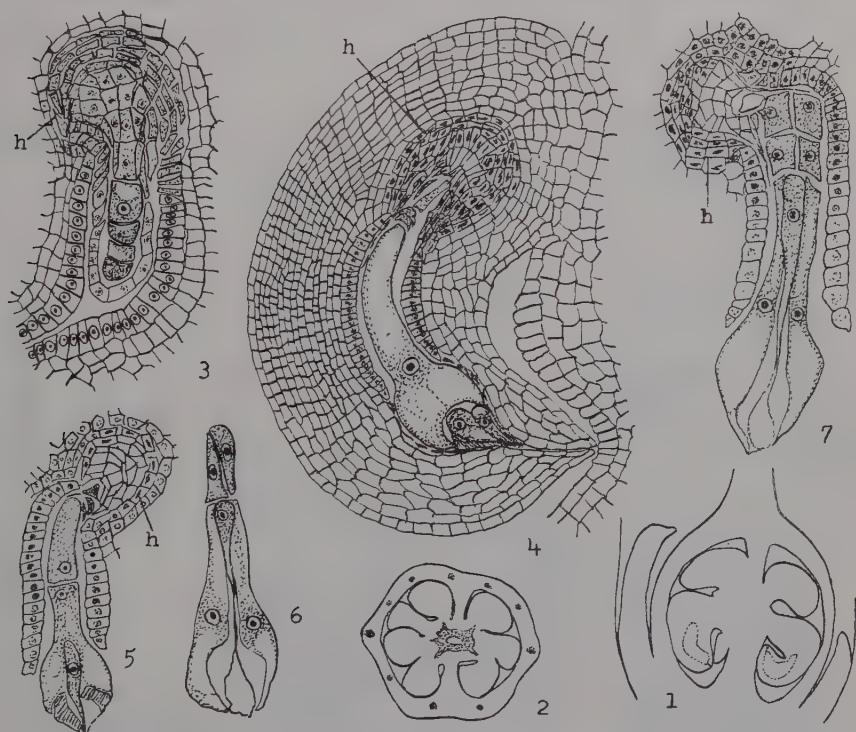
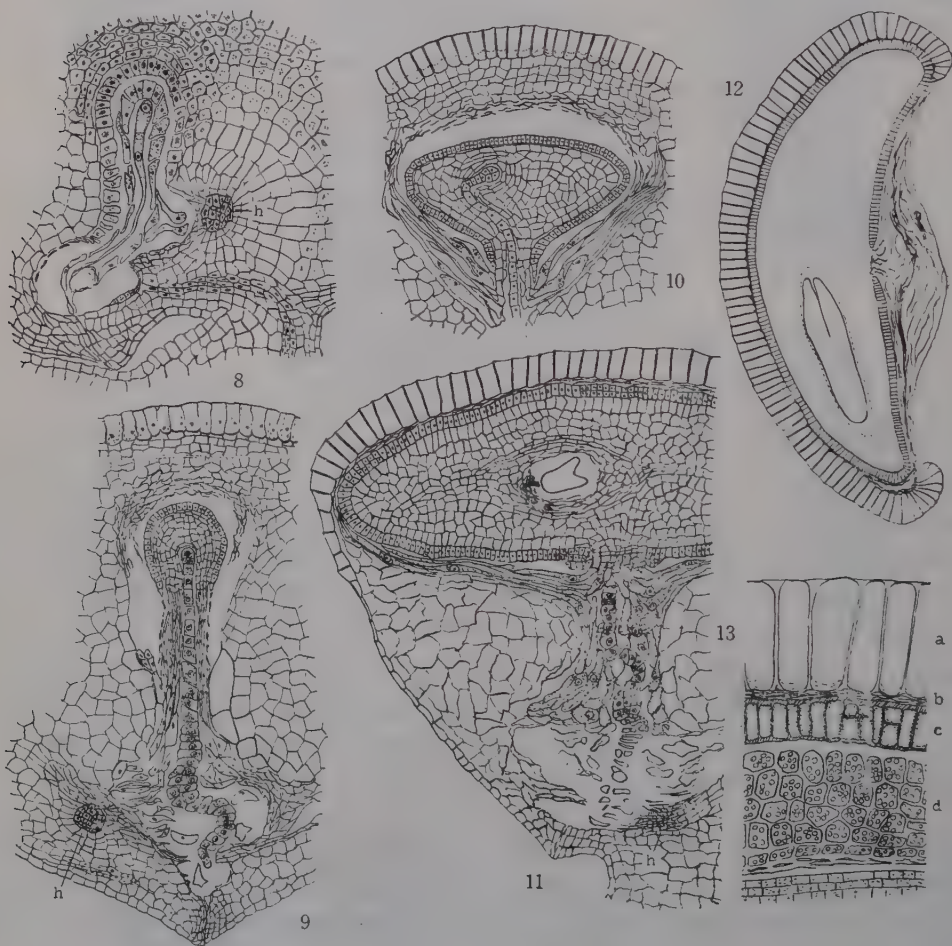


Fig. 1. Longitudinal section of the ovary, $\times 50$. Fig. 2. Transverse section of the ovary, $\times 50$. Fig. 3. Tetrads showing the upper three degenerated megaspores. $\times 500$. Fig. 4. Ovule showing the mature embryo sac. $\times 400$. Fig. 5. Two celled endosperm. $\times 400$. Fig. 6. Four celled endosperm. $\times 400$. Fig. 7. Six celled endosperm. $\times 400$.

Formation of the endosperm. The endosperm is of the cellular type. The embryo sac enlarges after fertilization. The first division of the primary endosperm nucleus takes place with a transverse wall to form a micropylar and a chalazal chambers (Fig. 5). Then longitudinal divisions in both cells result four-celled chambers (Fig. 6). These two micropylar chambers do not divide further and act as the haustorium, and two chalazal ones undergo further transverse divisions resulting two tiers of two cells each (Fig. 7). These four cells undergo further con-

tinuous transverse and longitudinal divisions to produce the endosperm proper. With the progress of the endosperm formation, the endosperm and the embryo become bent toward the dorsal side to penetrate into the integument (Fig. 8). In the second cell generation of the embryo, the cells of the dorsal side of the endosperm containing prominent nucleus and dense cytoplasm, rapidly divide forming the globular mass of cells, on the other hand, the cells of the micropylar and the chalazal parts of the endosperm become large and highly vacuolate (Fig. 9.). In the third and the fourth cell generations of the embryo, the dorsal globular mass of the endosperm gradually expands on the lateral side and forms a handle-shaped mass of cells containing dense cytoplasm. At the same time, some cells of the ventral side of the endosperm become swollen and highly vacuolate, and then are rapidly elongate and



Figs. 8-11. Formation of the seed. Fig. 8, $\times 140$. Figs. 9-10, $\times 80$. Fig. 11, $\times 60$. Fig. 12. Mature seed. $\times 35$. Fig. 13. A portion of the mature seed. $\times 160$ h-hypostatical region. a-epidermal cells. b-integumental cells. c-endothelial cells. d-endospermal cells filled with many starch grains. e-a portion of the embryo.

rise to an apical cell (ca) and a basal cell (cb) (Fig. 15). The basal cell (cb) repeats many continuous transverse divisions to produce an elongated filament which is composed of 40-50 cells (Fig. 9 and 18). These cells become swollen and highly vacuolate, and act as the suspensor haustorium. A terminal cell (ca) divides transversely into two superposed cells (cc) and (cd) (Fig. 19). The element (cd) divides transversely into two superposed cells (m) and (ci) (Fig. 20). The upper cell (m) differentiates as the hypophysial cell, and the lower cell (ci) accepts few transverse divisions and contributes to the construction of the upper part of the suspensor. At the third cell generation of the embryo, the elements (m) divides transversely to produce two superposed cells, (h) and (h') (Fig. 25). After the fourth cell generation, the cell (h) divides transversely to produce two superposed cells (iec) and (h') (Fig. 26). The element (iec) which is lenticular in shape and presses into the upper spheric part of the embryo, by two succeeded longitudinal divisions becomes four cells and represents the initials of the root cortex. The element (h') which by two succeeded longitudinal divisions gives rise four cells and by the next transverse divisions eight cells, represents the initials of the uppermost cell of the root cap (Fig. 34).

The uppermost cell (cc) divides longitudinally into two juxtaposed cells, whereupon each daughter cell undergoes a longitudinal division perpendicularly to the previous plane of division and produces four cells (Fig. 24). Transverse divisions in each of these four cells result two tiers of four cells each (l) and (l') (Fig. 25). Four cells of the upper tier (l) which give rise to the cotyledonary portion eventually, divide by tangential wall, thus formed outer daughter cells repeatedly divide anticlinally and give rise to the epidermal initials, the inner daughter cells then divides by generally vertical walls to separate the mother cells of the cotyledonary initials exteriorly and the elements which enter into the construction of the stem apex interiorly. Four cells of the lower tier (l') which give rise to the hypocotyledonary region, divide by vertical walls to produce eight cells (Fig. 27). Transverse divisions in each of these eight cells result two tiers of eight cells each (Fig. 28). Thus formed outer daughter cells repeatedly divide anticlinally and give rise to the epidermal initials, the inner daughter cells by the continuous periclinal and anticlinal divisions from the plerome initials (pl) and the periblem ones (pe) (Fig. 32). In transverse sections through the regions (l) and (l') (Fig. 30 and 31), four cells of each tiers are divide by a periclinal wall producing the outer more or less rectangular and four-sided cells (y) and the inner more or less triangular and three-sided ones (i). The cells of the outer element (y) repeatedly divide anticlinally and give rise to the epidermal initials. In the lower tier (l'), the cells of the inner element (i) repeat to divide periclinally and produce the outer sided cells (pe) representing the periblem initials and the inner three sided ones representing the plerome initials (pl) (Fig. 31).

Formation of the seed coat. Very early in the endosperm formation, many integumental cell layers are visible between the endothelium and the epidermis.

At the stage when the endospermal cells penetrate into the integument, the inner integumental cells are gradually broken down and the epidermal cells of the integument enlarge greatly. When the endosperm is fully developed, the inner integumental cells are completely disintegrate and remain in thin membrane. The epidermal cells of the integument elongate and become the mucilaginous hairs (Fig. 12 and 13).

Discussion. The processes of the endosperm and the embryo formations of *Ellisiophyllum pinnatum* remarkably differ from those of other members of Scrophulariaceae. In the former, the endosperm penetrates into the dorsal side of the integument, and the original part of the embryo sac is emptied its contents. Many lower endospermal cells elongate rapidly along the endothelium forming the filamentous cells which act as the haustorium. In the other members of Scrophulariaceae, the endosperm develops in the original part of the embryo sac, and the micropylar and the chalazal haustoria being constructed of one, two or four cells, are separately formed at either end of the endosperm.

Formation of the embryo of *Ellisiophyllum pinnatum* is essentially the same as those of other members of Scrophulariaceae, but some differences are found each others in the following respects. In *Ellisiophyllum pinnatum*, the terminal cell (ca) is segmented transversely to give rise two cells, (cc) and (cd). The uppermost cell (cc) is divided longitudinally into two juxtaposed cells and produces the stem tip, cotyledonary and hypocotyledonary portions. The lower cell (cd) produces the initials of the root cortex, root cap and the upper part of the suspensor. The basal cell (cb) of the two celled proembryo reports many transverse divisions to give rise the many-celled suspensor. These cells of the suspensor become swollen and act as the haustorium. These characters above mentioned are not found in other Scrophulariaceae, but are the same as those of *Hypericum perforatum* (Souèges 1925), *Androsaemum officinale* (Souèges 1936), and *Actinidia chinensis* (Souèges 1943).

In the other members of Scrophulariaceae, the terminal cell (ca) of two celled proembryo divides by a longitudinal wall giving rise two juxtaposed cells, and produces the stem tip, cotyledonary and hypocotyledonary portions. The lower cell (cb) produces the initials of the root cortex, root cap, and suspensor. This suspensor is slender and filamentous, and degenerates in early stages of the embryo development. The suspensor haustorium has never been found in Scrophulariaceae except an instance of *Striga lutea* reported by M. R. Mitchell (1915). However, B. Tiagi (1956) reported that "This observation of Mitchell is probably incorrect. Her figure 23 which represents this shows that she has mistaken the micropylar haustorial cell for a cell of the suspensor."

M. Honda (1930 and 1939) established an independent family Ellisiophyllaceae, or a subfamily Ellisiophylloideae in Scrophulariaceae based on this genus. The structure of the flower and the ovary of *Ellisiophyllum* is common to that of other members of Scrophulariaceae. But the above mentioned facts indicate that this

genus is very peculiar having certain special features of its own in embryology and holds a unique position in Scrophulariaceae.

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Some Dynamic Properties of the Protoplasmic Streaming in *Chara**

by Toshio HAYASHI**

林 俊郎**: シャジクモの細胞における原形質流動の動的観察

Received February 6, 1957

Many works have been done recently on the protoplasmic streaming in the myxomycete plasmodium regarding its motive force and energy source (Kamiya 1940-1956 and Ohta 1952). The dynamic properties of the protoplasmic streaming is so far best investigated in this material. The plasmodium of the myxomycete is, however, quite different from general plant cells both in appearance and behaviour. The rate of streaming of protoplasm in myxomycete is not only enormously high but the direction changes alternately according to a rhythmic pattern. Having no cell wall, the streaming of protoplasm in the plasmodium necessarily involves a change in shape.

On the other hand, our knowledge is still meager in respect to the dynamics of the rotational streaming. This paper deals with the effect of gravity and centrifugal acceleration on the internodal cell of *Chara*, one of the representative material showing rotational streaming, with the hope that it may throw some light on the dynamic character of the rotational streaming.

Material and methods

Internodal cells of *Chara Braunii* were used for material. The healthy internodal cells near the apical end, which are 0.5-3.0 centimeters long, are freed from the neighbouring cells for experiment.

* This work has been supported by a Grant in aid for Developmental Scientific Research of the Ministry of Education.

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In the experiment for investigating the effect of gravity on the rate of protoplasmic streaming (Exp. 1), an internodal cell was placed with its long axis vertical to the stage of a horizontal microscope. We measured the rate of the protoplasmic streaming on one side (Fig. 1) or on both sides of an indifferent zone of the cell; in the latter case the streaming takes place upward on one side and downward on the other. The measurement of the rate was repeated at least several times and sometimes twenty times.

The next step was to use a centrifuge-microscope of the type originally designed by R. Brown (1940). The apparatus was constructed by the author with a considerable modification suggested by Prof. H. Kinoshita of Tokyo University. The radius of its rotational part is two centimeters and the highest centrifugal acceleration is $800\times g$, the optical magnification being about $80\times$. For the estimation of its number of rotations, the stroboscopical method was applied. The material is placed in a special glass vessel as shown in Fig. 2. It is a square prism having a closed capillary inside, the bore of which is about 1.5 millimeter. This vessel, together with the material, is fitted in to the rotor of the centrifuge (Fig. 2).

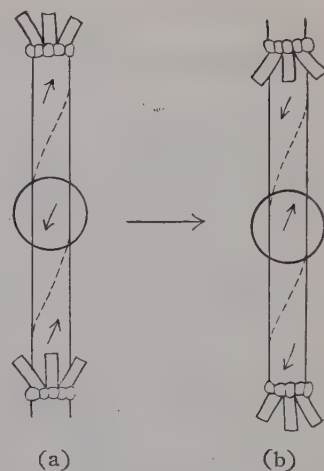


Fig. 1. An internodal cell in normal (a) and inverted (b) position. Circles represent the field of observation, small arrows representing the direction of protoplasmic streaming.

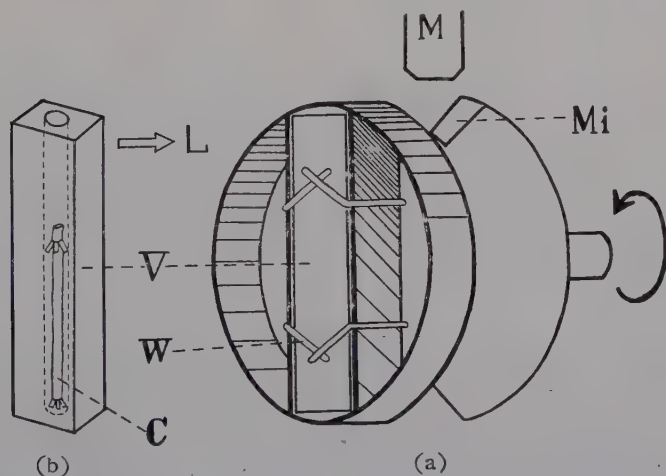


Fig. 2. (a) The rotor of the centrifuge-microscope constructed by the author. The radius of the rotor is 2 cm. The arrow indicates the direction of rotation. L: light incident upon mirror Mi attached to the rotor. V: vessel containing material. W: wire to hold the vessel in position. M: microscope. (b) shows the vessel mounted with an internodal cell. C: an internodal cell.

Results

Experiment 1. The effect of gravity on the rate of the protoplasmic streaming

We can see even under low magnification many large granules and a few chloroplasts floating in the streaming protoplasm of the internodal cell of *Chara*. These granules or chloroplasts are located near or at the boundary between the protoplasm and the vacuole.

When the cell is placed with its long axis vertical, we notice same difference in the rate of these granules, whether they are in the ascending or descending stream of protoplasm. This fact, which has been noticed by Ewart (1903) long time ago, implies that the rates of the upward and downward streaming of protoplasm which carries them are not the same. Table 1 shows the rates of the protoplasmic stream-

Table 1. The rate of endoplasmic flow near the vacuole

Streaming direction	Mean of the rate	Number of measurement	Number of reversal of cell position
downward	96.57±0.52	6	1
upward	94.94±1.44	4	2
downward	99.71±1.49	6	3
upward	94.15±0.48	5	4
downward	100.29±0.06	7	5
upward	93.37±0.28	4	6
downward	95.57±1.56	7	7
upward	96.84±1.33	6	8
downward	99.71±0.38	7	9
upward	95.48±0.46	5	10
downward	100.59±1.08	5	11
upward	97.40±1.14	10	
mean value of downward	98.91±0.60	38 (total)	
mean value of upward	95.36±0.58	34 (total)	

ming measured by the granules as index-markers at a definite portion of an internodal cell when the cell position was made upside down several times alternately by rotating the vertical stage of the horizontal microscope. It is noticed that the rate of upward streaming is, though little in amount, clearly less than the downward one. This difference in the rates is kept as long as the position of the cell is left unchanged. The mean values of the rate of upward and downward streaming, are 95.4 μ /sec. and 98.9 μ /sec. respectively.

In Table 2 are shown the results of the measurement of the rate of the upward

Table 2. The rate of ascending and descending streams on the opposite side of an indifferent zone measured at the innermost layer of the endoplasm

Experiment number	1		2		3	
Streaming direction	downward	upward	downward	upward	downward	upward
Mean value of velocity μ /sec	82.6 ± 0.46	79.5 ± 0.41	83.4 ± 0.52	79.3 ± 0.48	79.5 ± 0.60	77.7 ± 1.06
Number of measurement	23	23	24	24	10	10
u/v	52.3		39.7		87.3	

(continued)

4		5		6		Mean values	
downward	upward	downward	upward	downward	upward	downward	upward
80.5 ± 0.16	76.8 ± 1.10	78.4 ± 0.70	73.9 ± 0.98	78.2 ± 1.21	75.1 ± 0.98	80.4 ± 0.81	77.1 ± 0.82
12	12	6	6	7	7	82	82
42.5		32.9		49.5		50.87 ± 7.54	

and downward streaming on the opposite sides of, the indifferent zone, each 50μ apart from it. The mean values of six measurements are 77.1μ /sec. and 80.4μ /sec. for upward and downward streaming respectively, the difference between the two being 4.2 per cent. In Table 1 and 2, we notice a clear difference in the rate between the ascending and descending streams, though the absolute rate of flow is not equal according to the individual specimens and to the conditions of the experiment. This fact shows undoubtedly that gravity does affect the rate of the protoplasmic streaming to a certain extent. So far it is a further confirmation of the Ewart's observation.

What I would like to add here is a fact which was overlooked by Ewart that the minute granules which are located in the proximity of the cortical gel layer of the protoplasm, move with an equal rate no matter whether the stream occurs upwards or downwards (Table 3). Thus we can ascertain that the protoplasmic streaming which is directly in contact with the cortical gel is hardly affected by gravity, a fact which is not shared by the streaming of the endoplasm close to the vacuole.

Table 3. The rate of minute granules in endoplasm very near the cortical gel layer

Experiment number	1		2		3		Mean values	
Streaming direction	downward	upward	downward	upward	downward	upward	downward	upward
Mean value of velocity μ /sec	110.53 ± 2.94	109.09 ± 2.62	106.59 ± 1.06	105.13 ± 2.42	104.47 ± 1.54	104.47 ± 1.14	106.71 ± 1.73	106.71 ± 1.09
Number of measurement	10	10	10	10	10	10	30	30

This fact shows that there is a distinct difference in behaviour between the thin layer very close to the cortical gel and the other endoplasmic part, which flows

with a nearly equal rate in horizontal position (Kamiya & Kuroda, 1956). In order to elucidate this point, a further experiment was performed using a centrifuge-microscope.

Experiment 2. Observations of the protoplasmic flow under a centrifuge-microscope

We may assume that the rate of the protoplasmic streaming of *Chara* is not only dependent on its motive force but also on the protoplasmic viscosity. In order to exclude the effects of complex factors other than the motive force itself, we used a centrifuge-microscope by which we can observe the behaviour of the protoplasmic streaming under the centrifugal force. By this method, as Breckheimer (1949) reported, we see by the low centrifugal force acting in the direction of the longitudinal axis of the cell, that the streaming in the centrifugal direction is accelerated while that in the centripetal direction is retarded. The streaming in the centripetal direction can be brought to a standstill when it is subjected to a certain amount of centrifugal force. When the centrifugal force exceeds a certain amount, the direction of streaming is reversed from centripetal to centrifugal. In our experiment, we found that $40 \times g$ was necessary to stop the centripetal flow of endoplasm. Breckheimer (1949) reported $30 \times g$ was just sufficient to stop. These two values coincide fairly well.

It is true that these centrifugal accelerations are enough to stop the centripetal streaming of most part of the endoplasm, but a careful observation reveals that the minute particles which were streaming very near the cortical gel, still flow in the centripetal direction even under the same centrifugal acceleration. This flow balances usually with $200 \times g$, but sometimes it continues to stream even under as high an acceleration as $600-800 \times g$.

In Exp. 1 we did not find any significant difference in the rate of the endoplasmic streaming in the proximity of a gel layer, no matter whether the streaming was upward or downward. But, strictly speaking, there must have been a small difference in the rate, which however, was not more than the error of the measurement. We are now in a position to say in the light of the above observation using a centrifuge-microscope, that the centrifugal acceleration which just brings the centripetal streaming near the cortical gel to a standstill is very different from what is sufficient for suspending the centripetal flow of the massive part of the endoplasm.

Recently Kamiya and Kuroda (1956) analysed the velocity distribution of the protoplasmic streaming in *Nitella* cells and showed clearly that the motive force responsible for the protoplasmic streaming is developed at the interface region between sol and gel layers; all other part of streaming endoplasm is carried along passively.

The behaviour of the *Chara* cell under the influence of gravity or centrifugal acceleration, which has been described in the foregoing, is quite in conformity with the results and conclusion of Kamiya and Kuroda. The above data further support

the assumption that the mechanism of the motive force generation is not distributed over the streaming endoplasm, but exists only at the boundary region between the cortical gel and the endoplasm.

Considerations

The difference in rate between upward and downward streaming in the internodal cell of *Chara*, has been known since Ewart (1903). In our experiment shown in Table 1, the rate of the upward streaming was $95.4 \mu/\text{sec}$. and that of the downward streaming amounted to $98.9 \mu/\text{sec}$. Suppose the original streaming rate of the cell is U , and the absolute amount of increment or decrement under the influence of the gravity is V , we have the following relations for the upward and downward streaming, namely,

$$U - V = 95.4 \text{ (upward streaming)}$$

$$U + V = 98.9 \text{ (downward streaming)}$$

From these formulae, we know U is 97.13 and V is 1.77 and hence $U/V = 55$. Then through calculation from Table 2, we get, as a mean value: $U/V = 50$. If we may assume that the value of V is proportional to the value of the gravity, we can predict from the above formulae just how much acceleration is sufficient to stop the centripetal streaming. The value from the above formulae is 50–55 times gravity, while the value obtained by the centrifuge-microscope method is $40 \times g$. The coincidence is rather satisfactory. Hence, we can expect that the mass streaming of protoplasm has a balance-acceleration of about 40–50 times gravity in the mean value.

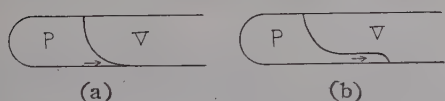


Fig. 3. Contours of the boundary between endoplasm (P) and vacuole (V) at the centrifugal end of an internodal cell.

(a): under $100 \times g$ centrifugal acceleration.

(b): under $0-20 \times g$ centrifugal acceleration.

Arrows show the direction of protoplasmic streaming.

the form shown in Fig. 3 (b) (T. Hayashi 1952). These contours of the boundary line between the protoplasm and the vacuole under different centrifugal accelerations also show a difference in behaviour between the protoplasm which is in direct contact with the cortical gel and that in the inner layer.

The author would like to express his cordial thanks to Prof. Noburô Kamiya of University of Osaka, for his helpful advice and directions throughout this work.

On the other hand, the balance-acceleration for the thin layer close to the cortical gel to stop, has been known to be much greater than that for most part of the endoplasm. We find this fact also in Fig. 3 (a) (Breckheimer 1949, 1951) which shows the profile of the centrifugated plasm observed under the acceleration of $100 \times g$ following $200 \times g$ acceleration in several minutes. When centrifugal acceleration is decreased to $0-20 \times g$, this boundary line takes

He would also like to express his appreciation to Prof. Bungo Wada and Prof. Dyûhei Sato of University of Tokyo, for support of this work.

Summary

1) In the protoplasmic streaming of *Chara*, we can see a difference between the flowing rate of upward streaming and that of downward streaming. This is true in respect to most of the endoplasm, except that which is in direct contact with the cortical gel. The rate of the latter streaming is not affected by gravity.

2) By means of a centrifuge-microscope, we find that the centripetal flow of the endoplasm stops under the influence of centrifugal acceleration amounting to $40\times g$. But the endoplasm adjacent to the cortical layer requires five times as much centrifugal acceleration as the above in order to be brought to a standstill.

3) The mechanism of the motive force generation exists only at the boundary region between the cortical gel and the endoplasm, and all the other portions of the endoplasm are thought to be passively driven by the force generated at this region.

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Fruit Body Formation of Red Bread Mold

Neurospora crassa II.

Effect of Ammonium and Nitrate Ion Concentration on the Perithecial Formation

by Taro Ito*

伊藤太郎*: アカパンカビの子実体形成 II. 被子器形成に対するアムモニウム並びに硝酸イオン濃度の影響

Received February 11, 1957

In order to analyse the physiological mechanism of sexual reproduction of heterothallic fungi, it has been attempted to study the effects of the culture filtrate of either mating types on the formation of fruit body (1)(2)(6)(8). Previously the effect on the formation of perithecia of the single strain culture filtrate of the basal culture medium which contained either nitrate or ammonium type nitrogen was investigated with aim to detect whether the perithecial formation degree of the single

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culture filtrate obtained from different media supplemented with nitrogen sources of different types is different from each other or not (3). And it became clear that, among nitrate types, potassium nitrate in the a(−) strain culture filtrate appeared more effective in promoting the perithecial formation than that in the A(+) strain culture filtrate; while, on the other hand, among ammonium types, ammonium chloride in the A(+) strain culture filtrate was more effective than that in the a(−) strain culture filtrate. It was assumed, therefore, that for perithecial formation of each mating type required nitrogen of a different sort, in different amount, as nitrogen source in its culture medium.

From this point of view, the author investigated the efficiency of the culture filtrate from inorganic nitrogen source containing either NH_4^+ or NO_3^- for perithecial formation.

Material and Method

The strains used in the present experiment are the same ones, a couple mating wild type of *Neurospora crassa* 4A(+) and 8a(−) (hereafter they are referred to A(+) and a(−)) used in the previous experiment(4). These strains have normal characteristics in external features, for mycelium, macro- and micro-conidium. They form fruit bodies by crossing at any time. The basal culture medium contained the following gradients in 1 liter of distilled water; $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ 5 gm., NH_4NO_3 1 gm., $\text{KH}_2\text{PO}_4 \cdot 7\text{H}_2\text{O}$ 0.5 gm., NaCl 0.1 gm., CaCl_2 0.1 gm., sucrose 15 gm.. The nitrogen source was changed according to the experimental aims.

The liquid basal medium 100ml adjusted to pH 6 before sterilization, a loopful of spore suspension of both A(+) and a(−) strain was inoculated; then incubated at 26°C for 72hr. in a black chamber. The culture filtrate used in this experiment was prepared by removing mycelial mat grown in the 50ml liquid basal medium which was supplemented with different nitrogen sources substituting for ammonium tartrate and ammonium nitrate according to different experiment aims.

The formation test of the fruit body was carried out by counting the number of both mature and immature perithecia formed on 10ml agar medium slant, after 15–20 days of incubation, added 1 ml of the culture filtrate produced from the liquid basal medium before solidification. First, in order to determine a suitable nitrogen type and to analyse the effect of the culture filtrate at various amount ratio of the nitrogen sources, the effect of inorganic nitrogen source containing either NH_4^+ or NO_3^- was estimated by number of perithecia formed on agar slant supplemented with the culture filtrate of either A(+) or a(−) single strain (hereafter they are referred to either +CF or −CF) and A(+) & a(−) mixed strain (hereafter it is referred to $\pm\text{CF}$).

Experimental Results

I. Effect of inorganic nitrogen on the formation of perithecia

In order to test the effect of nitrate, nitrite and ammonium type nitrogen on the formation of perithecia, the type of nitrogen for the development of the vigorous perithecial formation, the time required for first appearance of perithecium and the number of perithecia per mol concentration unit were investigated according to the method previously described. Various nitrogen sources used were NaNO_3 , NaNO_2 , $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$, NH_4Cl and NH_4NO_3 . To test the effect of nitrate, nitrite and ammonium type nitrogen upon perithecial formation, counted was the number of perithecia which were formed by sexual mating type(A(+)&a(-)) strain on agar medium 5ml flooded by the liquid basal medium containing various nitrogen sources. For the test of the effect of the culture filtrate upon perithecial formation counted was the number of perithecia which were formed by sexual mating type on agar medium flooded by the culture filtrate produced from the liquid basal medium containing various nitrogen sources inoculated by either A(+) or a(-) strain and kept at 26°C for 72hr..

Table 1. Effect of inorganic nitrogen sources and their culture filtrates on the perithecial formation

Nitrogen source						Culture filtrate					
Type		gm. per liter	mol	No. of perith. (L.p.) *	No. of perith. per mol	A(+) single strain		a(-) single strain		A & a(+&-) mixed strain	
						Growth** amount (mg.)	No. of perith. (L.p.)	Growth amount (mg.)	No. of perith. (L.p.)	Growth amount (mg.)	No. of perith. (L.p.)
NO_3	NaNO_3	3	3.5×10^2	8(7)	$2 \times 3 \times 10^2$	17	0	10	0	16	0
NO_2	NaNO_2	1	$1.5 \times "$	45(7)	$30.0 \times "$	0.2	12(7)	0.1	21(7)	0.4	30(7)
NH_4	$(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$	5	$2.7 \times "$	13(7)	$4.8 \times "$	437	13(5)	400	10(5)	320	17(5)
	NH_4Cl	1	$1.9 \times "$		$0.7 \times "$						
$\text{NH}_4 + \text{NO}_3$	NH_4NO_3	1	$1.3 \times "$	65(7)	$50.0 \times "$	247	60(5)	203	60(5)	257	54(5)
	$(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$	5	$2.7 \times "$		$24.0 \times "$						

* Lag period so far first perithecia are formed. ** Dry weight of mycelial mat of A(+) and a(-) strain grown in basal medium for obtaining culture filtrate.

The highest formation activity was present at 1gm. of NH_4NO_3 ($1.3 \times 10^{-2}\text{M}$) and at 5gm. of $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ ($2.7 \times 10^{-2}\text{M}$). The total mol concentration was $4 \times 10^{-2}\text{M}$. The number of perithecia per 1 mol concentration of nitrogen source also was the maximum at 1gm. of NH_4NO_3 ($1.3 \times 10^{-2}\text{M}$) and 5gm. of $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ ($2.7 \times 10^{-2}\text{M}$) and minimum at 1gm. of NH_4Cl ($1.9 \times 10^{-2}\text{M}$). The time required for first appearance of perithecia was 5 to 7 days and it seemed to be shortened by adding the culture filtrates. Furthermore, it was noted that although the growth amount of mycelial mat of A(+), a(-) single strain and A & a(+ & -) mixed strain were best at 5gm. of $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ ($2.7 \times 10^{-2}\text{M}$) and 1gm. of NH_4Cl ($1.9 \times 10^{-2}\text{M}$) the culture filtrate produced from these nitrogen sources hardly allowed to develop perithecium so well as those produced from the other nitrogen sources.

II. Differential effect of nitrate and ammonium type nitrogen on the formation of perithecia (culture duration 72hr.)

1. The effect of NH_4^+ and NO_3^- on the perithecial formation

To test the effect of the culture filtrate produced from the basal medium containing NH_4NO_3 and $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ upon perithecial formation two experiments at different relative amount of these compounds of the total mol concentration ($4 \times 10^{-2}\text{M}$) were made.

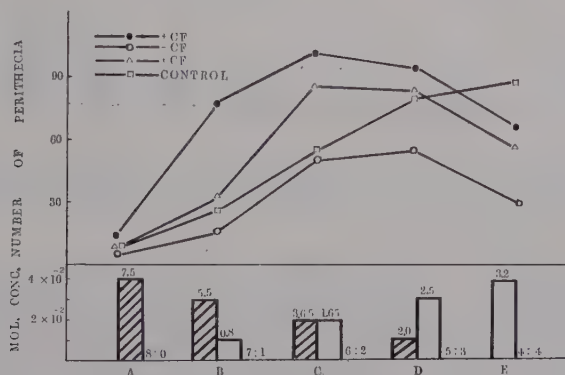


Fig. 1. Perithecial formation by +CF, -CF and \pm CF from the medium containing $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ and NH_4NO_3 at different concentration ratio.

The signs used in the figure show the following notes: —●—; perithecial formation by +CF, —○—; perithecial formation by -CF, —△—; perithecial formation by \pm CF: $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$, NH_4NO_3 ; The numerals on the upper and right part of the sign of concentration ratio indicate the amount (gm./l.) and the ratio $[\text{NH}_4^+]:[\text{NO}_3^-]$ of these nitrogen source.

Fig. 1. showed that the rating of perithecial formation increased proportionally to an increase of NH_4NO_3 content in the medium. When $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ was substituted for NH_4NO_3 completely, the maximum state was met (Fig. 1-E). However, when the culture filtrate obtained from these nitrogen sources was supplemented to the medium monomial frequency curves were obtained and principal feature was alike inspite of different source of filtrate (Fig. 1-C).

2. The differential effect of NH_4^+ and NO_3^- on the formation of ascocarpous organ

As shown in the previous experiment, the culture filtrate obtained from the medium containing 3.65 gm. of $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ and 1.65 gm. of NH_4NO_3 had the maximum effect upon the perithecial formation (Fig. 1-C). In order to examine this concentration ratio of nitrate and ammonium nitrogen at which the maximum perithecial formation was present, the perithecial formation effect of nitrogen sources containing NH_4^+ and NO_3^- to either single sexual mating type strain A(+) or a(-) at various amount ratio of NH_4Cl , NH_4NO_3 and KNO_3 was investigated.



Fig. 2. Perithecial formation of single sexual strain by +CF, -CF and \pm CF from the medium containing NH_4Cl , NH_4NO_3 and KNO_3 at different concentration ratio

The signs used in the figure show the following notes; —●—; perithecial formation of a (-) single strain by +CF, —○—; perithecial formation of A(+) single strain by -CF, —▲— & —△—; perithecial formation of a(-) and A(+) single strain by \pm CF: ▨; NH_4Cl , □; NH_4NO_3 , ■; KNO_3 . The numerals on the upper and right part of the sign of concentration ratio indicate the amount (gm. per liter) and the ratio $[\text{NH}_4^+]:[\text{NO}_3^-]$ of these nitrogen sources.

The +CF showed the maximum formation of perithecia at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and 1 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$) (Fig. 2-E). These perithecia, however, contained neither asci nor ascospores (ascocarpous organ). On the other hand, the -CF showed the maximum formation of perithecia at 0.53 gm. of NH_4Cl ($1 \times 10^{-2}\text{M}$) and 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) (Fig. 2-C).

III. Differential effect of nitrate and ammonium type nitrogen on the formation of perithecia (culture duration 168hr.)

1. The effect of NH_4^+ and NO_3^- on the perithecial formation

Though the time of incubation was 72 hr. in the previous experiment, it was extended to 168 hr. in this experiment. Under this condition of the prolonged culture the effect of the culture filtrate on perithecial formation was investigated.

The maximum perithecial formation of the +CF, -CF and \pm CF was seen at the amount ratio of 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and 1 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$) (Fig. 3-F). The number of perithecia formed by these culture filtrate decreased according to decreasing of NH_4NO_3 and increasing of KNO_3 (Fig. 3,F-I). It had been shown that perithecial formation presented by the culture filtrate is indirectly related to a particular concentration ratio of ammonium and nitrate ion contained in the medium.

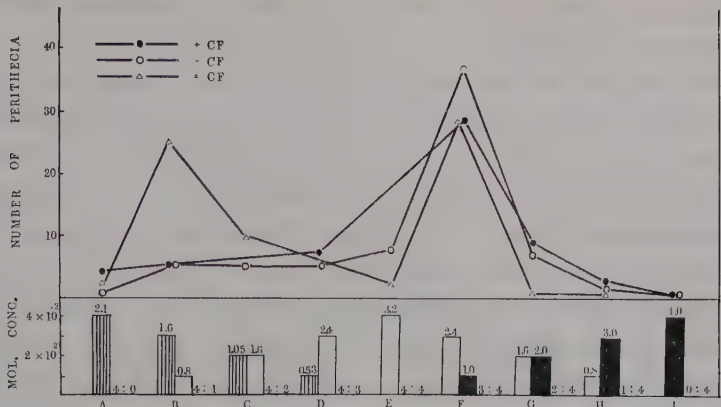


Fig. 3. Perithecial formation by +CF, -CF and ±CF from the medium containing NH_4Cl , NH_4NO_3 and KNO_3 at different concentration ratio.

The signs used in the figure show the following notes: —●—; perithecial formation by +CF, —○—; perithecial formation by -CF, —△—; perithecial formation by ±CF: ▨; NH_4Cl , □; NH_4NO_3 , ■; KNO_3 : The numerals on the upper and right part of the sign of concentration ratio indicate the amount(gm./l.) and the ratio $[\text{NH}_4^+]:[\text{NO}_3^-]$ of these nitrogen sources.

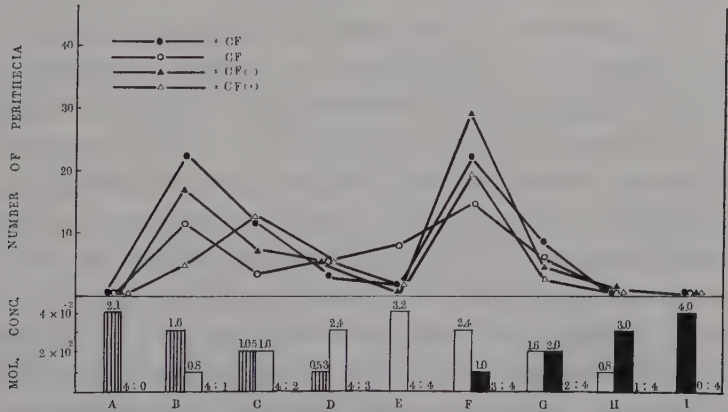


Fig. 4. Perithecial formation of single sexual strain by +CF, -CF and ±CF from the medium containing NH_4Cl , NH_4NO_3 and KNO_3 at different concentration ratio. The signs used in the figure show the following notes: —●—; perithecial formation of a(-) single strain by +CF, —○—; perithecial formation of A(+) single strain by -CF, —△— & —△—; perithecial formation of a(-) and A(+) single strain by ±CF: ▨; NH_4Cl , □; NH_4NO_3 , ■; KNO_3 : The numerals on the upper and right part of the sign of concentration ratio indicate the amount (gm./l.) and the ratio $[\text{NH}_4^+]:[\text{NO}_3^-]$ of these nitrogen sources.

2. The differential effect of NH_4^+ and NO_3^- on the formation of ascaropous organ

Further experiment was performed to examine the amount ratio of nitrate and

ammonium nitrogen at which the maximum perithecial formation of the culture filtrate to the single sexual mating type strain was present.

As shown in Fig. 4, the +CF showed the maximum formation of perithecia at 1.6 gm. of NH_4Cl ($3 \times 10^{-2}\text{M}$) and 0.8 gm. of NH_4NO_3 (10^{-2}M), at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and 1.0 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$) (Fig. 4-B&F) and the -CF showed the maximum formation at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and 1.0 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$) (Fig. 4-F). On the other hand, the \pm CF showed the maximum formation at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and 1.0 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$) (Fig. 4-F). The number of perithecia formed by these three culture filtrates decreased according to increasing of the amount of NH_4NO_3 and KNO_3 and decreasing of NH_4Cl and NH_4NO_3 (Fig. 4, B-E, F-I). Thus it had been considered that the number of perithecial formed by the culture filtrate was a function of the amount of nitrogen sources added to the basal medium for the culture filtrate.

Discussion

It seems very important and interesting to comprehend mechanisms of sexual reproduction of heterothallic fungi biochemically. As far as the present knowledge extends, the effects of the culture filtrate produced from the basal medium containing various nitrogen sources upon the formation and development of perithecia, asci and ascospores have never been described. A. Nason et al. (5) reported that the mycelial incubation with either deficiency of nitrogen or a limited amount of nitrogen produced a marked increase in DPN-ase and a decrease in alcohol dehydrogenase. It is considered that such alteration in the cellular condition also should be taken into consideration when we deal with the relationship between the formation of perithecia and the functions of the nitrogen sources. In this report only the effect of inorganic type nitrogen on the perithecial formation will be referred to basing upon the experiment data described.

Westergard & Mitchell(7) reported that KNO_3 was the most effective nitrogen source for perithecial formation of all types of nitrogen source, comparing the rating of perithecial formation in various nitrogen sources by visual estimation. However, they had recognized also that an addition of a bit of ammonium tartrate (0.05 gm./1.) to a synthetic medium containing KNO_3 shortened a lag of first appearance of perithecium. This probably indicates that the presence of both NH_4^+ and NO_3^- at suitable equilibrium in the medium would have promoted the formation of perithecia. As shown in Fig. 1, the number of perithecia formed on agar slant medium supplemented with NH_4NO_3 and $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ at different concentration ratio is nearly proportional to increasing concentration of NH_4NO_3 and to decreasing concentration of $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$. Thus it is presumably suggested that the highest effect will be revealed at the equimolar concentration of NH_4^+ and NO_3^- (Fig. 1-E). On the other hand, the effect of the \pm CF and +CF was present most remarkably at the almost equal amount of either nitrogen sources, and the -CF had the highest

effects at a little richer amount of NH_4NO_3 than that of the other nitrogen sources $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$. The highest effect of the culture filtrate will be revealed at the ionic concentration ratio $[\text{NH}_4^+]:[\text{NO}_3^-]=6:2$ as shown in Fig. 1-C. Thus it appears that a proper balance between the concentration of NH_4^+ and NO_3^- is a prerequisite for the formation of perithecia in this strain.

The same general conclusion was obtained in the preceding experiment by comparing with the number, which was near the maximum, of the perithecia formed by the +CF, -CF and \pm CF to single sexual mating type strain mycelia (Fig. 2 & 4). In Fig. 2 the +CF and -CF produced perithecia vigorously at the amount of 0.53 gm. of NH_4Cl ($1 \times 10^{-2}\text{M}$), 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$), 1 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$); on the other hand, as shown in Fig. 4, similarly at 1.6 gm. of NH_4Cl ($3 \times 10^{-2}\text{M}$), 0.8 gm. of NH_4NO_3 ($1 \times 10^{-2}\text{M}$) and at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$), 1 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$). The author(4) pointed out already, that the perithecial formation activity of the \pm CF consists of the perithecial formation activities of the +CF, -CF and possibly other factors. If the perithecial formation is based upon the formation activity of both the +CF and -CF to either a(-) or A(+) single mating type strain mycelia, the concentration ratio of nitrate and ammonium ion required for presenting of the maximum effect of the \pm CF should correspond to the sum of either ionic concentration ratio at which the +CF and -CF reveal the maximum perithecial formation effect. As shown in Fig. 2-E, the ionic concentration ratio of NH_4^+ and NO_3^- at which the +CF showed maximum perithecial formation activity was approximately 3:4. On the other hand, in Fig. 2-C, the concentration ratio of NH_4^+ and NO_3^- at which the -CF showed maximum perithecial formation activity was approximately 4:3. The summation of the two ionic concentration ratios at which the +CF and -CF showed maximum perithecial formation activity as shown in Fig. 4-B & F was 25:12. Hence it is conceivable that the maximum formation effect will be presented at the ionic concentration ratio $[\text{NH}_4^+]:[\text{NO}_3^-]>1$. However, as seen in Fig. 3-F and Fig. 4-F, the maximum effect presented by the +CF at 2.4 gm. of NH_4NO_3 ($3 \times 10^{-2}\text{M}$) and 1 gm. of KNO_3 ($1 \times 10^{-2}\text{M}$) must be considered most carefully. If mycelial fusion accompanied by heterokaryosis occurs vigorously with prolongation of the time of incubation for obtaining culture filtrate, the vigorous formation of perithecia of the \pm CF to single strain A(+) and a(-), as shown in Fig. 4-F, should be owing to some activity of the mycelial fusion and heterokaryon formation. Though in the case of the 72hr. culture duration the ionic concentration ratio of the maximum formation of the \pm CF was approximately 4:3 (Fig. 2-C), in the case of the 168 hr. it was 3:4 (Fig. 4-F). Supposing that mycelial fusion accompanied by heterokaryosis occurred owing to prolongation of incubation duration and some activity of mycelial fusion stimulated perithecial formation, in the case of the 168 hr. the maximum formation revealed at the ionic concentration ratio 3:4 might be depend upon some activity brought by the excess of NO_3^- .

As a consequence of these considerations, the effect of NH_4NO_3 upon the normal perithecial formation would be composed of the effects of NH_4^+ and NO_3^- at a particular concentration ratio and the other effects of NO_3^- .

The author wishes to express his cordial thanks to Dr. N. Tanaka for his kind and valuable suggestion and correction of this manuscript.

Summary

In this report the effect of inorganic nitrogen containing NH_4^+ and NO_3^- upon the perithecial formation in Red Bread Mold, *Neurospora crassa*, was studied. The nitrogen source containing NH_4^+ and NO_3^- was effective for the perithecial formation rather than the nitrogen source containing each one of either NO_3^- , NO_2^- or NH_4^+ respectively. The culture filtrate produced from the basal medium containing NH_4^+ and NO_3^- as nitrogen source showed the maximum perithecial formation effect when the medium was supplemented with the richer concentration of NH_4^+ than that of NO_3^- .

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Effects of Temperature on Reversion Rate of *Ustilago maydis**

by Tatsuo ISHIKAWA** and Nobunori TANAKA**

石川辰夫**・田中信徳**： トウモロコシノクロホキンの復帰変異率に及ぼす温度の影響

Received February 18, 1957

The effects of temperature on mutation rate are a very significant problem for studying the mechanism of mutation, because it is considered that mutation is a variation comparable with a chemical reaction. Plough (1941) studied this problem in *Drosophila* and found that the frequency of mutants followed a typical Van't Hoff's curve with a temperature coefficient of 5.

In microorganisms, temperature coefficients have been reported to be from 0 to 5, e. g. 2.5 and 5.0 in *Phytomonas stewartii* (Lincoln 1947), about 2 in *Bacterium prodigiosum* (Kaplan 1947) and 1.8 in *Escherichia coli* (Novick and Szilard 1950). The mutations studied in these microbes were of a morphological nature or to phage resistance. In this paper, the effects of temperature on the reversion rate of four different strains of *Ustilago maydis* all of which required homocysteine have been analysed thermodynamically. Based on the results obtained, the energy states of the genes in question have been investigated.

Materials and Methods

The four homocysteineless mutants used in the present experiments were strains 5-103, 4-24, T4004 and T4005; the first two strains were kindly supplied by Dr. D. D. Perkins and the latter two were isolated from an unstable strain T4001 (Ishikawa unpublished). These strains require either L-homocysteine or L-methionine, but fail to grow in minimal medium supplemented with other substances related to methionine synthesis.

The culture media and basic techniques were described already by Perkins(1949), and Ishikawa and Tanaka (1956). To determine the mutability at various different temperatures, these strains were cultured at 0, 7, or 5 and 10, 15 20, 25, 30 and 35°C.

Reverted colonies were detected by the following procedures: (1) An adequate number of parent sporidia suspended in complete medium were distributed in 1 ml lots into 10 sterile tubes at each temperature; (2) after incubation at each tem-

* Contributions from the Divisions of Genetics and of Cytology, Botanical Institute, Faculty of Science, University of Tokyo, No. 365. The present study was carried out partly by grants from the Scientific Research Fund of Ministry of Education.

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perature for 72 hours, each culture was independently centrifuged and washed 3 times in 0.9% saline; (3) then, the number of sporidia per tube was estimated; (4) all the sporidia of each tube were plated on minimal agar media (for 4-24 alone, minimal medium supplemented with 1×10^{-5} mg methionine ml^{-1} was used in order to check partial reversion types); (5) after 7 days' incubation the number of reverted colonies was counted.

The mean number (m) of mutations was calculated from the median value in the frequency-distribution of the reverted colonies according to Lea and Coulson's formula (Lea and Coulson 1949) or by the zero term of the Poisson distribution (Ryan and Wainwright 1954). The mutation rate (a) per sporidium per generation is given by the formula,

$$a = \frac{m \ln 2}{N}$$

where N denotes the mean number of sporidia per tube. The reversion rate per unit time could easily be computed when the generation time was determined.

Results

It has been reported that three groups of homocysteineless mutants of *Ustilago maydis* differed significantly in their spontaneous reversion rates (Ishikawa and Tanaka 1957). The 1st group (H^{-1}) was most stable and the spontaneous reversion rate was 9×10^{-8} per sporidium per hour at 30°C ; the 2nd group (H^{-2}) was somewhat more unstable, reverting in a rate of 2×10^{-6} , and 3rd group (H^{-3}), the most unstable, reverted in a rate of 2×10^{-5} . Among the H^{-2} , strain 4-24 was characterized by yielding partial reversion types (Ishikawa and Tanaka 1956). In the present experiment, strain T4004 (H^{-1}), strain T4005 and 4-24 (H^{-2}), and strain 5-103 (H^{-3}) have been used to study the effect of temperature on reversion rate. The results obtained are summarized in Table 1. It is to be noticed that when reversion rate is computed per sporidium per generation as shown in 6th column of Table 1 the mutation rate increased at lower temperature and a minimum value was found around 20°C . But generation time varies at different temperatures, as shown in 3rd column of Table 1. Since it has been proved by Ryan (1955) that another mutation can occur in nondividing cells, mutation rate per sporidium per hour is the most adequate unit for expressing the effects of temperature on mutation.

It will be seen in Table 1 that in three strains of T4004, T4005 and 5-103 an almost proportional correlation seems to exist between reversion rate and temperature. In strain 4-24, however, no such clear relationship has been found, one maximum existing at 20°C .

The temperature coefficients (Q_{10}) calculated from these measurements are 3.9, 2.2 and 1.8 in strains T4004, T4005 and 5-103 respectively.

If we assume that mutation occurs as a monomolecular reaction, the reaction velocity should correspond to mutation rate and we could apply following equation

Table 1. Reversion rate of four homocysteineless strains of *Ustilago maydis* grown at various temperatures for 72 hours.

Strain	Temperature (°C)	Generation time (hours)	Sporidia per culture	Mean number of reversions	Reversion rate	
					per sporidium per generation	per sporidium per hour
T4004	0	>72	9.3×10^5	0.3	2.6×10^{-7}	3.6×10^{-9}
	7	>72	2.1×10^6	2.3	7.5×10^{-7}	1.0×10^{-8}
	13	>72	1.5×10^6	2.4	1.1×10^{-6}	1.5×10^{-8}
	20	9.5	4.3×10^6	2.4	3.8×10^{-7}	4.0×10^{-8}
	25	9.3	1.4×10^6	1.6	8.0×10^{-7}	8.6×10^{-8}
	30	7.4	2.8×10^6	2.7	6.8×10^{-7}	9.2×10^{-8}
	35	72	1.6×10^5	0.5	2.2×10^{-6}	3.1×10^{-7}
T4005	0	>72	4.3×10^5	5.7	9.1×10^{-6}	1.3×10^{-7}
	5	>72	6.1×10^5	14	1.2×10^{-5}	1.7×10^{-7}
	10	>72	4.6×10^5	1.4	2.1×10^{-5}	2.9×10^{-7}
	15	18	4.0×10^5	8.7	1.5×10^{-5}	8.3×10^{-7}
	20	9.4	5.0×10^4	0.4	4.8×10^{-6}	5.1×10^{-7}
	25	8.9	9.1×10^4	1.1	8.4×10^{-6}	9.5×10^{-7}
	30	7.0	1.2×10^5	22	1.3×10^{-5}	1.9×10^{-6}
5-103	0	>72	2.7×10^3	1.1	3.2×10^{-4}	4.5×10^{-6}
	7	>72	6.6×10^3	2.3	2.4×10^{-4}	3.3×10^{-6}
	13	32.7	2.1×10^4	3.7	1.2×10^{-4}	3.7×10^{-6}
	20	7.2	8.1×10^4	10	8.8×10^{-5}	1.2×10^{-5}
	25	7.6	5.7×10^4	11	1.3×10^{-4}	1.7×10^{-5}
	30	4.4	1.6×10^5	21	8.9×10^{-5}	2.0×10^{-5}
	35	6.6	9.0×10^4	19	1.4×10^{-4}	2.1×10^{-5}
4-24	0	>72	1.1×10^5	14	8.8×10^{-5}	1.2×10^{-6}
	5	>72	1.2×10^5	13	7.3×10^{-5}	1.0×10^{-6}
	10	55.0	2.9×10^5	21	5.0×10^{-5}	9.1×10^{-7}
	15	13.8	3.1×10^5	2	4.4×10^{-5}	3.2×10^{-6}
	20	6.2	1.3×10^5	14	7.5×10^{-5}	1.2×10^{-5}
	25	5.7	5.5×10^5	9.7	1.2×10^{-5}	2.1×10^{-6}
	30	5.6	1.3×10^6	9.6	5.1×10^{-6}	9.1×10^{-7}
35	>72		5.7×10^4	14	1.7×10^{-4}	2.4×10^{-6}

for the rate (*a*).

$$a=nCe^{-W/RT} \dots\dots\dots(1)$$

where *nC* is a constant value and considered to be a frequency factor, *W* is activation energy of the gene in question, *R*, the constant, 0.86×10^{-4} ev, and *T*, the absolute temperature.

The logarithm of equation (1) is:

$$\ln a=\ln nC-W/RT$$
$$\log a=\log nC-W/1.98 \times 10^{-4}T \dots\dots\dots(2)$$

we can see almost linear correlation between *log a* and 1/*T* in Fig. 1, and can take the tangent of the line which represents the value $W/1.98 \times 10^{-4}$. Therefore, the activation energy, *W* and the frequency factor, *nC* can be obtained in the relationship in Fig. 1 and equation(2). *W* and *nC* values of T4004, T4005, 5-103 and calculated by the present authors from measurements reported in literatures follow:

Organisms	Strain or mutation	<i>a</i> (hour ⁻¹)	<i>Q</i> ₁₀	<i>W</i> (ev)	<i>nC</i> (hour ⁻¹)	Author
<i>Ustilago maydis</i>	T4004	9.2×10^{-8}	3.9	0.92	3.2×10^8	present data
"	T4005	1.9×10^{-6}	2.7	0.65	1.1×10^5	"
"	5-103	2.0×10^{-5}	1.8	0.42	1.7×10^2	"
"	T4001	1.2×10^{-4}	1.3	0.24	1.2×10^0	Ishikawa unpublished
<i>Drosophila</i>	CIB	2.8×10^{-5}	6.6	1.35	8×10^{17}	cited by Kaplan
"	bb	1.1×10^{-6}	3.8	0.95	6.6×10^9	" (1947)
"	chromosome II	1.0×10^{-4}	5	1.25	9×10^{16}	Plough (1941)
<i>Bacterium prodigiosum</i>	r	7.9×10^{-4}	2.1	0.53	3.3×10^6	Kaplan (1947)
"	W ₁	4.6×10^{-3}	2.0	0.53	2.5×10^6	"
"	W ₂	2.7×10^{-3}	2.1	0.59	1.7×10^7	"
<i>Phytomonas stewartii</i>	400	1.3×10^{-4}	5.7	1.37	8.1×10^{18}	Lincoln (1947)
"	401	1.8×10^{-5}	2.7	0.80	3.6×10^8	"
<i>Escherichia coli</i>	T ₅ Resist.	8.3×10^{-9}	1.8	0.48	8.3×10^{-1}	Novick and Szilard (1950)

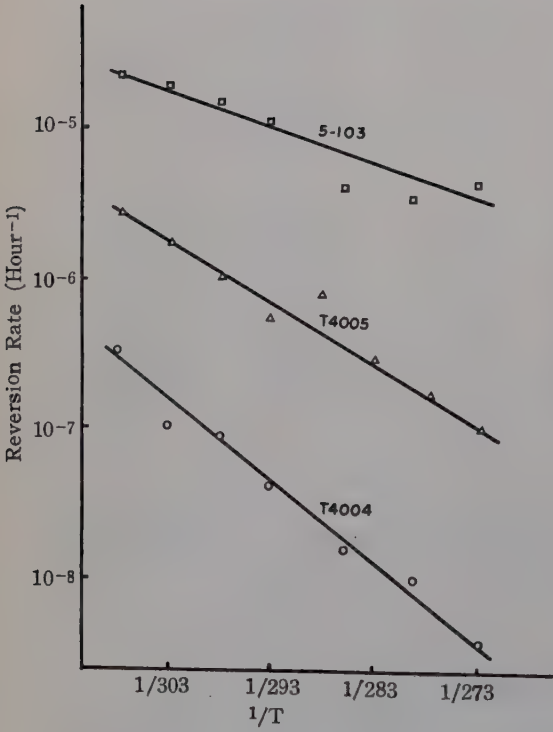


Fig. 1. Effect of temperature on reversion rate in three strains of *Ustilago maydis*.

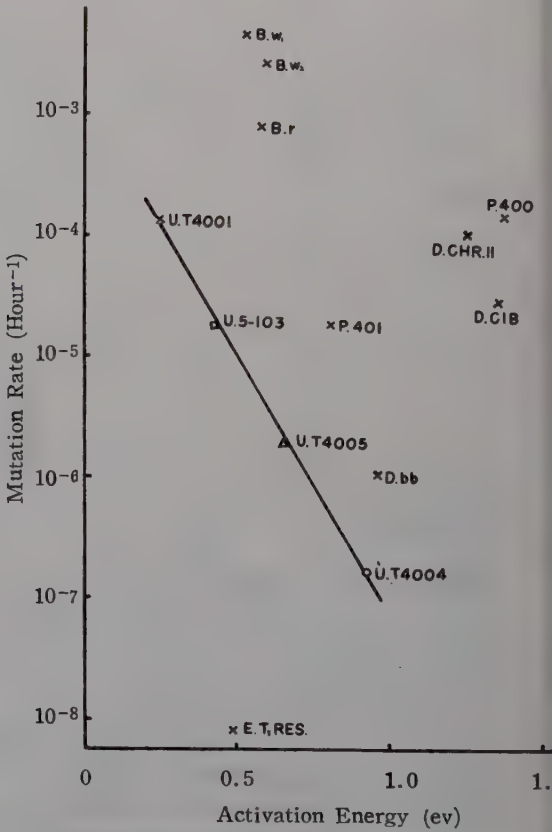


Fig. 2. Relationship between activation energy and mutation rate in 13 mutations referred. B.-*Bacterium prodigiosum*; D.-*Drosophila*; E.-*Escherichia coli*; P.-*Pseudomonas stewartii*; U.-*Ustilago maydis*.

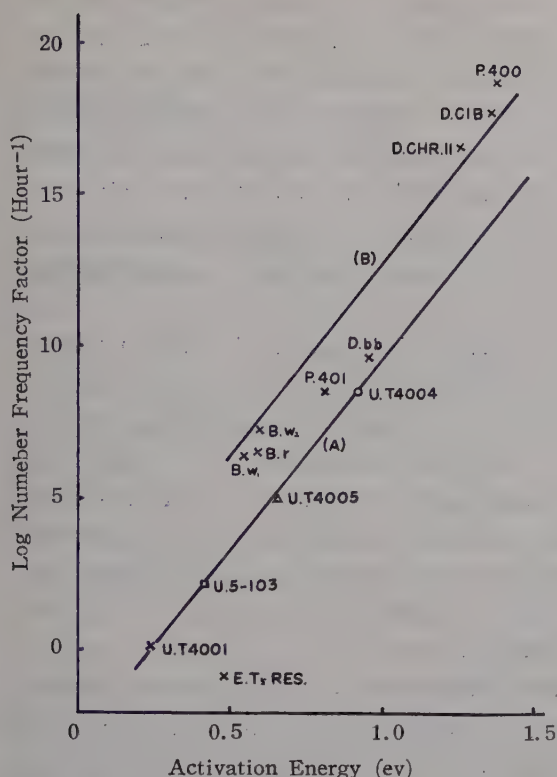


Fig. 3. Relationship between activation energy and log number of frequency factor in 13 mutations referred. B.—*Bacterium prodigiosum*; D.—*Drosophila*; E.—*Escherichia coli*; P.—*Pseudomonas stewartii*; U.—*Ustilago maydis*.

to see whether or not they correlate with each other. Two linear correlation lines, (A) and (B), are obtained. The single measure of phage T₅ resistance in *E. coli* is separated. Line (B) contains mutations measured by the CIB method and on chromosome II of *Drosophila*, in strain 400 of *Phytomonas stewartii* and in *Bacterium prodigiosum*. Line (A) contains the other mutations referred to.

Discussion

The relation between temperature and mutation rate per generation represents the number of mutations occurring during the period of one generation at various temperatures. But generation time varies significantly in cultures incubated at different temperatures. Since mutation can occur independently of cell division (Novick and Szilard 1950, Ryan 1955) and increase of mutation was shown in aged seeds (cf. Gunthardt *et al.* 1953), it is reasonably presumed that the probability to mutate becomes larger as generation time is prolonged. The results obtained coin-

It has to be mentioned that since the temperature coefficients of these various organisms had been measured in the range of temperatures in which they were cultured, in the values of a now listed, an arbitrary change, when necessary as in the cases of *Drosophila* or *E. coli*, has been made to ease comparison among different species. These values were re-calculated at the level of 30°C. Of course, this temperature seems unusual for *Drosophila*, but it has been assumed that the present conversion could be materialized.

The mutation rates were plotted against W -values in Fig. 2. A linear correlation was found for the four strains of *Ustilago maydis*, but no such relationship obtained for the figures for other organisms.

In Fig. 3, the activation energy and log nC -values for the 13 examples referred to are reproduced

cide with this presumption and suggest that mutation will occur in the course of metabolism for duplication of genic material as a function of the time for the metabolism. Therefore, the effect of temperature on mutation rate has to be expressed as a rate per cell per unit time in order to exclude the difference in generation time. From this view point, the fact that mutation rate increases at lower temperatures in higher organisms (cf. Roades 1941, and Faberge and Beale 1946) has to be reconsidered in relation to this discrepancy. It also seems necessary to reappraise other complicated effects of temperature on mutation of microorganisms (cf. Lincoln 1949).

Definite temperature coefficients were found in the relation between temperature and mutation rate per hour. It could be deduced theoretically from equation (1) that the higher the mutation rate, the smaller the temperature coefficient. In fact, data presented in this paper accord well with this presumption. Temperature coefficients in the range of 1 to 4 for the biochemical mutations studied in the present experiments are almost the same as the values calculated by other authors and seem to correspond to Van't Hoff's coefficient. It is rather curious that temperature had displayed no effects on phage T_1 resistant mutation (Witkin 1953). A maximum effect of temperature on mutation was shown in strain 4-24. As already reported in a previous paper (Ishikawa and Tanaka 1956), strain 4-24 has a rather complex nature inasmuch as it reverted to wild type through 3 steps inspite of the single block between cystathionine and homocysteine which is presumed to be a one step reaction. The reason why temperature has maximum effect on mutation at 20°C is yet unclear.

An hypothesis developed from biochemical considerations on mutation is that mutation is a biochemical reaction with a definite temperature coefficient. Then, equations (1) and (2) were postulated for the mutation rate, activation energy and frequency factor as shown by Timofeeff-Resovsky *et al.* (1953), Schrödinger (1943) and McElroy and Swanson (1951). According to these equations, the values of activation energy and frequency factor were obtained for some organisms. The definite correlation between log number of mutation rates and activation energy in the 4 mutants of *Ustilago maydis* related to homocysteine synthesis shows that similar genic substances are involved in mutations and that the substances differ from each other only in energy for activation.

Two kinds of linear correlation, (A) and (B), were found between activation energy and log number of frequency factor. The mutations of chromosomes of *Drosophila* and of *Phytomonas* on (B) should concern many genes. If n is 10^3 or 10^4 in (B), and $\log nC/n$, which will represent the frequency factor for one gene, is plotted against activation energy according to Kaplan (1947), the (B) line will coincide with (A) except for the mutations in *Bacterium prodigiosum*. This does not fit Kaplan's consideration in which the 3 mutations of *Bacterium prodigiosum* are related with few genes. However, as far as this experiment is concerned, it will

be suggested that the log number of the frequency factor for a gene becomes proportional to its activation energy. Differences in the reversion rates, activation energies and frequency factors may indicate that the genic situation in the 3 groups of homocysteineless strains differs thermodynamically, suggesting a situation similar to pseudoallelism.

Summary

The reversion rates per unit time of homocysteineless strains of *Ustilago maydis* were determined at seven or eight temperatures. The temperature coefficients were 3.9, 2.2 and 1.8 and activation energies, 0.92, 0.65, and 0.42 ev respectively.

The relationships between reversion rate and activation energy, and between frequency factor and activation energy were analyzed. It was suggested that the various mutants have a pseudoallelic nature.

The authors wish to express their thanks to Dr. F. J. Ryan for his helpful advice and suggestions given in this work and thanks are also due to Dr. D. D. Perkins who has kindly supplied the original strains of *Ustilago maydis*.

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Effects of Monochromatic Ultraviolet Rays on Yeast Cells.

V. Color Change of Carotenoid Pigment in the Parent and the Variant Strains under Cool Condition*

by Shoitiro IGUTI**

井口昌一郎**：低温培養に於ける酵母のカロチノイド色素の変化
(酵母細胞に及ぼす単色紫外線の影響 V)

Received March 23, 1957

In the preceding papers (Iguti, 1953, 1955), it was shown that seven variant strains of the yeast, *Torula rubra* Saito, were obtained by irradiation with ultraviolet light at wave lengths of 2618 Å and 2825 Å, and with unfiltered ultraviolet. Six of these strains (2606r, 2613, 2805r, 2814, uv-11r and uv-18r) grew rapidly, and the seventh (2616), slowly. In the winter of 1954-55, the writer observed on occurrence of unexpected color changes in the colonies of these strains, outside of the incubator. Then, attempt was made to gain fundamental information as to the effect of temperature upon the colonial color and to investigate the nature of the pigment of these strains, with special reference to color variations occurring at low temperatures. Following are the results obtained, as regards both visible color shades and absorption spectra of the carotenoid pigment of the organisms when reared under both warm and cool conditions.

The writer wishes to express his sincere thanks to Prof. Dr. Y. Yamaguti for valuable suggestions and criticisms, and to Dr. Y. Watanabe for active interest and generous assistance in preparation of the manuscript. Thanks are also due to Mr. T. Takano of the Faculty of Education, Ibaraki University, who gave ample facilities for the use of the Beckman spectrapotometer.

Material and Method

Yeast strains and culture medium. The above mentioned seven variants and the parent strain were cultured at 7-10° C for 6-7 weeks and at 22°-25° C for 3-4 weeks. At the end of the culture periods, extraction of the pigment were made for absorption spectrography. Colors of the colonies reared on cool slant agar were examined 3, 7, 14, and 21 days after inoculation, and those reared under warm conditions after 7, 14, and 28 days. The culture medium employed consisted of 1 liter of distilled water, 150 gm cane sugar, 15 gm peptone, 5 gm KH_2PO_4 , 2 gm MgSO_4 , 10 cc yeast extract, and 20 gm agar. After boiling, 7 cc of the medium was introduced into a series of test vials for sterilization and use.

* Contribution from the Biological Institute of Ibaraki University, No. 21

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Extraction and fractionation of pigments. Fresh 1 gm of each strain was ground, and then extracted with methanol and petroleum ether by turns. The resulting residues were again extracted repeatedly with carbon bisulphide until they were completely decolorized; the extracts were dried in the current of air free from oxygen by having been passed through alkalic pyrogallol solution, dissolved into a small quantity of petroleum ether, and put together with the above mentioned petroleum ether and methanol extracts. With a small volume of water (10 per cent of the methanol quantity) added to this mixture, some parts of the pigment were driven into the petroleum ether layer, and then collected by means of a separatory funnel. In the methanol layer were found some xanthophylls, slightly yellow in tint; this layer was shaken together with a small quantity of petroleum ether in order to collect other petroleum ether-soluble parts still retained in it. After separating it from the methanol fraction, the collection was put in the above-mentioned petroleum ether fraction. Thereafter, all the petroleum ether fractions were washed clean of methanol, and treated with a 5 per cent alcoholic potassium hydroxide solution at a temperature of 5-7° C for saponification. After an 18 hour period of saponification, with use of some water (20 per cent of alcoholic quantity), most of the neutral pigments were transferred from the mixture to the petroleum ether layer, and prepared as an orange-colored solution by repeating saponification and fractionation (Yamazaki et al., 1941). The alcoholic hydroxide fraction being well washed with, and then separated from, petroleum ether, a rose-colored solution of acidic pigments was obtained. For quantitative measurements, the endvolume of the petroleum ether, the methanol and the alcoholic hydroxide extracts was adjusted, each with its own solvent used, to 15, 20 and 33 cc, respectively.

Absorption measurement. The absorption of the extracts of definite endvolumes was determined in the spectral range of 340 to 660 m μ in the Beckman quartz photo-electric spectrophotometer.

Results and General Remarks

Effect of temperature upon colonial color. At temperatures of 22° to 25° C, no notable difference can be seen in colonial color in these strains, all assuming an orange tint within one week after inoculation. But when aged, they come to show delicate differences in color shade: the parent strain becomes slightly dirty-orange; both strains of 2805r and uv-11r, slightly orange-red; and the others (2814, 2606r, 2613 and 2616 strains), slightly red-orange (Table 1). In contrast, at low temperatures (below 10° C), the colonies begin to change their initial orange tint within one week after transplantation from the warm cultures, and take on different color shades in different strains within three weeks. The results are given in Table 2. In most of the strains, as shown by the tabulated data, low temperature appears to tinge the colonies with red, to a greater or lesser degree. These findings may indicate that the strains differ as regards activity of pigment formation, and that the diffe-

rences in colonial color are greatly enhanced under cool temperature conditions. When replaced in the incubator and reared at 27° C, the colonies found to have been diversely pigmented at low temperature come to have rather similar shades, as was found in *Rhodotorula glutinis* (Nakayama, 1952), but they still show delicate differences in tint, i. e., either orange or red-orange, or orange-red, according to the nature of the strains.

Table 1.

Colonial Color Shades of the Strains
Cultured at 22-25°

strain	one week	four weeks
parent	orange	slightly dirty orange
2805r	"	slightly orange-red
2814	"	slightly red-orange
uv-11r	"	slightly orange-red
uv-18r	"	slightly red-orange
2603	"	" " "
2613	"	" " "
2616	"	" " "

Table 2.

Colonial Color Shades of the Strains
Cultured at 5-7°C

strain	3 days	7-14 days	21 days
parent	orange	orange	red-orange
2805r	"	slightly orange	light orange
2814	"	orange-red	red
uv-11r	"	light rose	rose-red
uv-18r	"	light rose	rose-red
2606r	"	orange-red	dirty orange-red
2613	"	rose	rose red
2616	"	slightly dirty orange	dirty red-orange

Absorption-spectroanalysis of the extracts.

1. Methanol extracts. The spectrophotometric data on the methanol extracts from the cultures at temperatures of 10° C and 25° C are graphed in Figures 1 and 2. Within the range of 340 to 660 m μ , there is found in the methanol extracts neither a characteristic absorption band nor any appreciable difference in absorption curve at different temperatures. This may suggest that methanol-soluble pigments probably nothing to do with the difference in colonial color, and that low temperatures, such as 10° C, scarcely affect that development of these pigments by the organisms, except for the 2805r strain, in which the production of a pigment or pigments, with two absorption maxima present at 524 and 550 m μ , is slightly stimulated by low temperature.

2. Petroleum ether extracts. Absorption spectra of the petroleum ether extracts are presented in Figures 3 and 4; Figure 3 represents the data obtained from the cultures at 10°C, and Figure 4, those from the cultures at 25°C. The graphed data in these figures show that the extracts from the cool cultures have two absorption maxima, generally at ca. 450 and ca. 480 m μ , while those from the warm cultures, with the exception of the extracts from the parent strain, give a slight indication of another maximum at ca. 520 m μ . Therefore, the principal pigment in the petroleum ether extracts may be regarded as β -carotin, having a three banded spectrum with the maxima at 451, 484 and 521 m μ (Lederer, 1938). In each strain, upon exposure to a low temperature of 10°C, the pigments soluble in petroleum ether are considerably increased, but with their third maximum, at ca. 520 m μ , being inconclusively noted, it still remains to be proved whether these pigments are the same as those produced at high temperature.

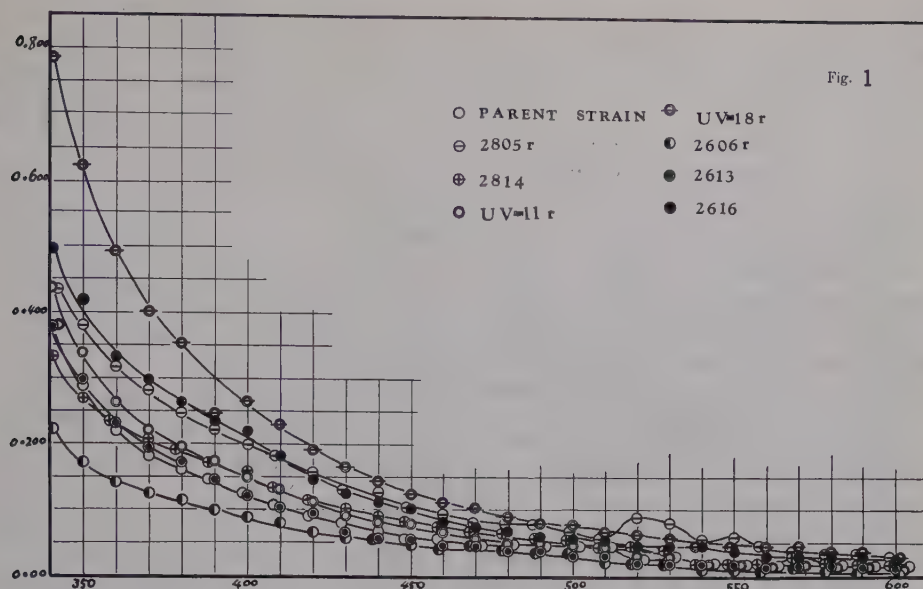


Fig. 1

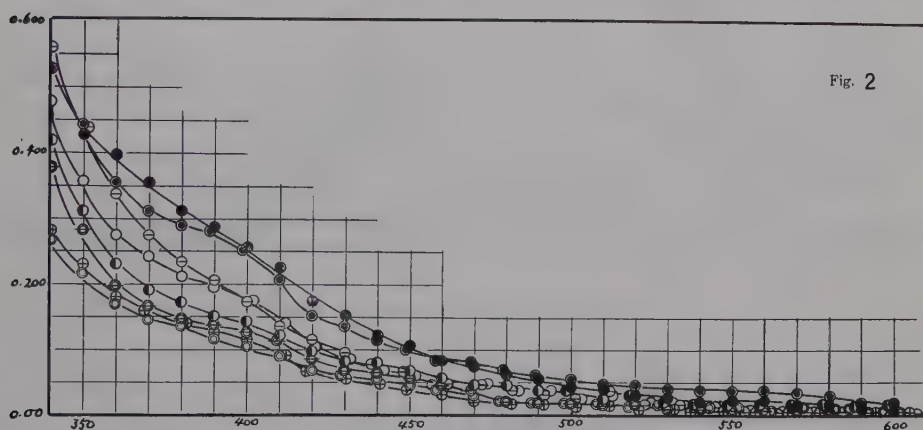


Fig. 2

Fig. 1 and 2. Absorption spectra of methanol extracts from the cool cultures (Fig. 1) and from the warm cultures (Fig. 2). Ordinates represent extinction value, E , and abscissae, wave length in $m\mu$. Symbols in Fig. 2. as in Fig. 1.

3. Alcoholic potassium hydroxide extracts. The results obtained are graphically represented in Figures 5-8; the data on the cool cultures are given in Figures 5 and 6, and those on the warm cultures, in Figures 7 and 8. As shown by these graphed data, the decrease in temperature from 25° to 10°C results in a marked increase of the alcoholic hydroxide-soluble pigments, absorption maxima of which are in the spectral ranges of $460-475$, $490-500$ and $520-530 m\mu$ each. But in the range of $460-475 m\mu$ in the extracts from the warm cultures, parent and the 2805r strains, and in those from the cool cultures, strains 2814 and 2613, and also in the range of $520-530 m\mu$ in the extracts from the warm culture of the 2606r strain, the maximum is not present. Thus, the pigment in these extracts seems to be either a certain

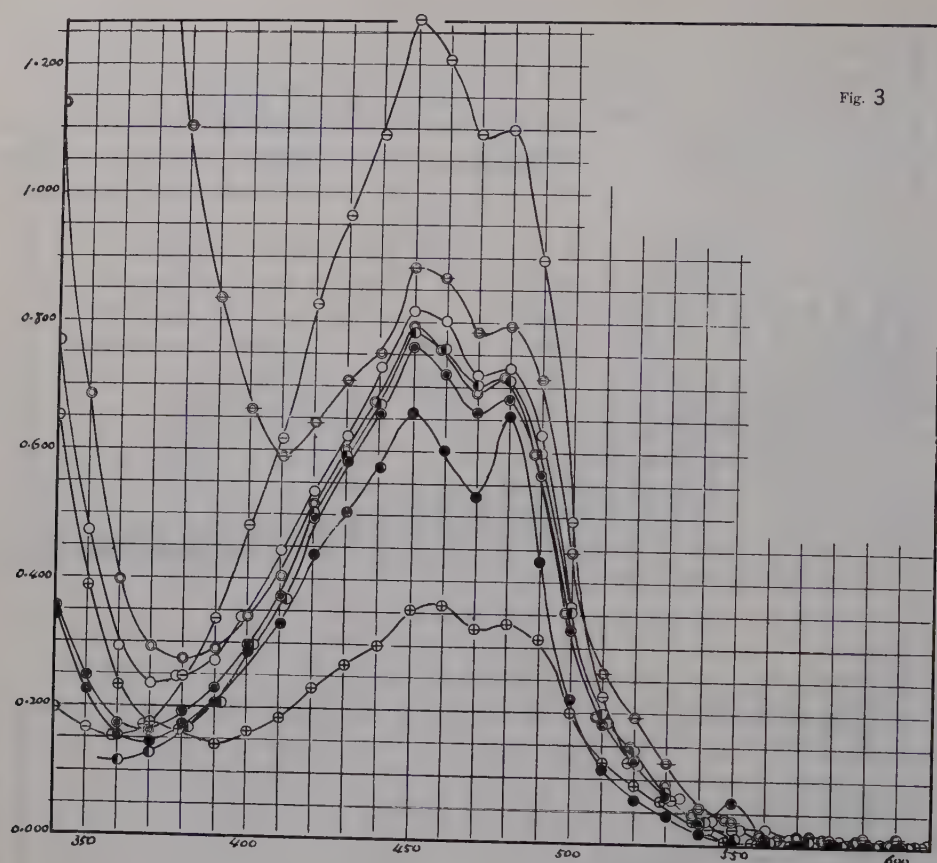


Fig. 3

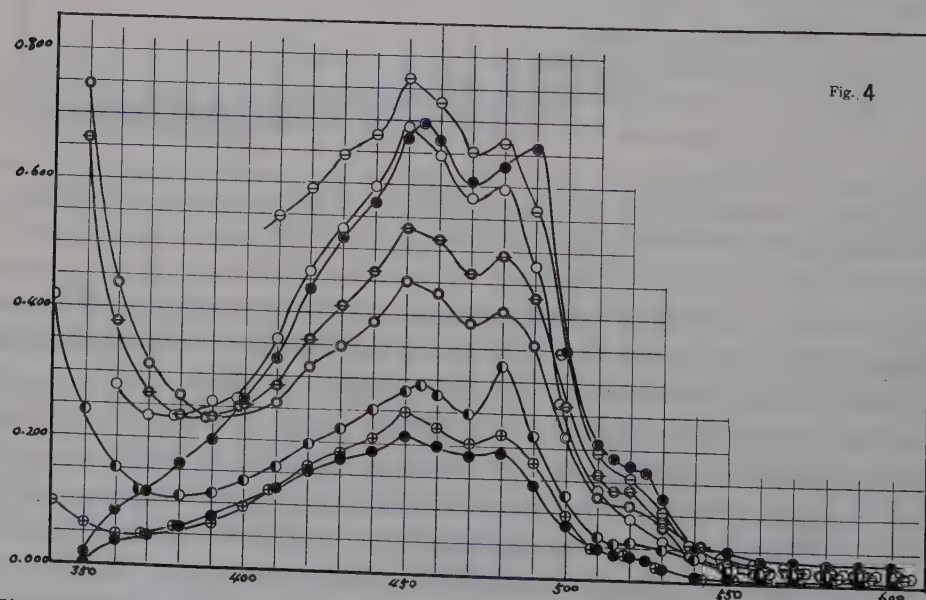


Fig. 4

Fig. 3: and 4. Absorption spectra of petroleum ether extracts from the cool cultures (Fig. 3), and from the warm cultures (Fig. 4). Ordinates, abscissae and symbols as in Fig. 1.

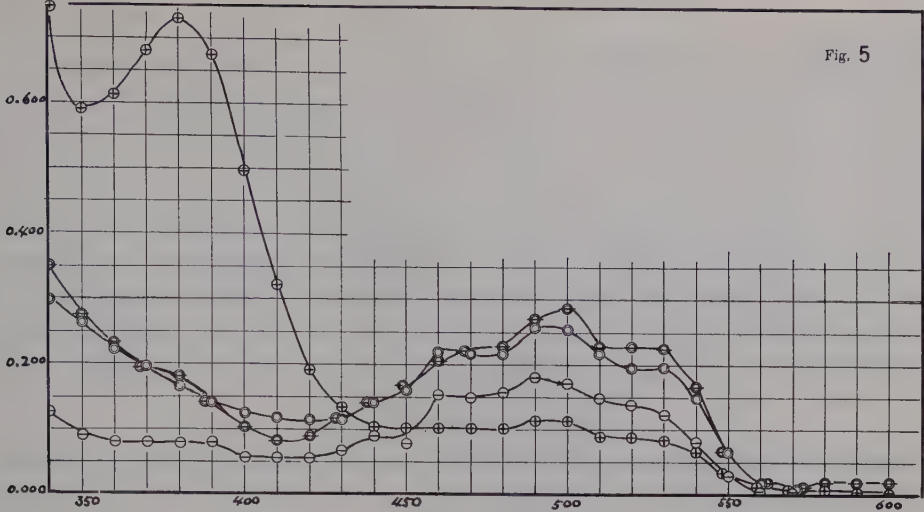


Fig. 5

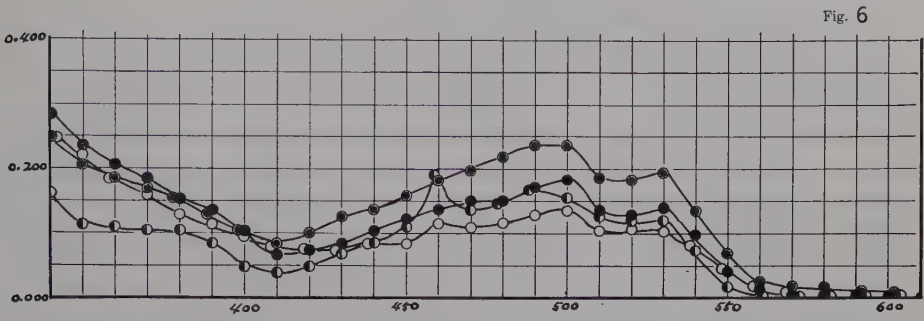


Fig. 6

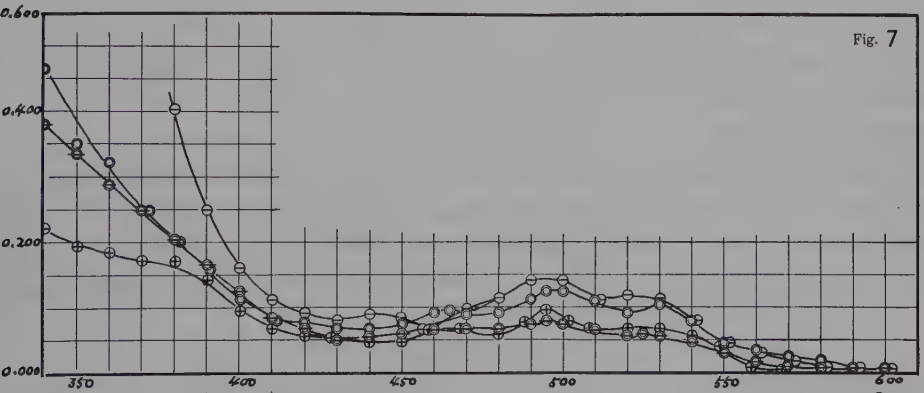


Fig. 7

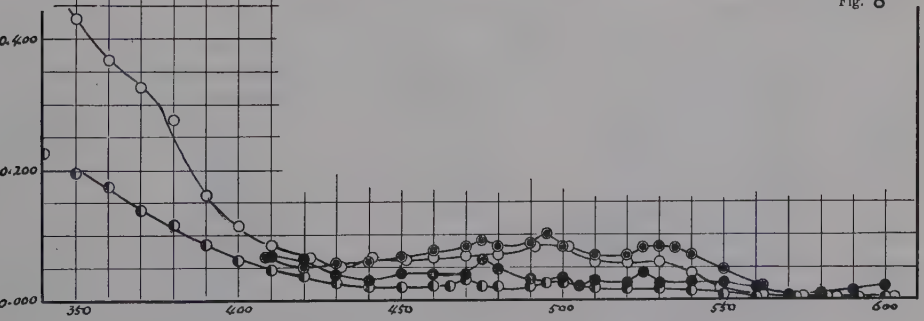


Fig. 8

Figs. 5-8 Absorption spectra of alcoholic hydroxide extracts from the cool cultures Fig. 5 and 6). and from the warm cultures (Fig. 7 and 8). Ordinates, abscissae and symbols as in Fig. 1.

carotenoid complex or an unknown pigment with a three-banded spectrum present.

General remarks. As has been pointed out, the methanol-soluble pigments are not closely associated with the differences in colonial color. In the color shades of the present material, either the orange color of the petroleum ether extract or the rose color of the alcoholic hydroxide extract is evidently predominant. However, the differences in extinction value at the wave length of maximum absorption, $E(\lambda \text{ max.})$, of either extract are found by no means to be in accordance with those in colonial color shade (Table 3 and 4). But it seems still to be within the bounds of possibility that the color shades are concerned in some way or other with the relative

Table 3.

Colonial Colors and $E(\lambda \text{ max.})$ values of the alcoholic hydroxide and the petroleum ether extracts of the Strains Reared at 10°C.

strain	colonial color on 21th day	$E(480m\mu)$ for petroleum ether extract	$E(490m\mu)$ for alcoholic hydroxide	Ratio
parent	red-orange	0.730	0.135	0.185
2805r	light orange	1.100	0.181	0.164
2814	red	0.335	0.120	0.358
uv-11r	rose-red	0.717	0.257	0.358
uv-18r	rose-red	0.795	0.288	0.362
2606r	dirty orange-red	0.712	0.166	0.233
2613	rose-red	0.682	0.240	0.352
2616	dirty red-orange	0.657	0.183	0.279

amounts of the pigments contained in the two extract. To examine whether this is really the case, the ratio of $E(\lambda \text{ max.})$ of the alcoholic hydroxide extracts to that of the petroleum ether extract is calculated for each strain, and listed in the last columns Tables 3 and 4.

By reference to the data given in Table 3, it will be seen that in the cool cultures of the strains examined, the variations in $E(\lambda \text{ max.})$ ratio afford a rather close parallel to those in the colonial color, and the colonies become increasingly reddish with increase in this ratio, as in the case of *Rhodopseudomonas spheroides* (van

Table 4.

Colonial Colors and $E(\lambda \text{ max.})$ values of the alcoholic hydroxide and the petroleum ether extracts of the Strains Reared at 22-25°C

strain	colonial color on fourth week	$E(480 \text{ or } 490m\mu)$ for petroleum ether extract	$E(490 \text{ or } 500m\mu)$ for alcoholic hydroxide extract	Ratio
parent	slightly dirty orange	0.595	0.085	0.143
2805r	slightly orange-red	0.667	0.150	0.225
2814	slightly red-orange	0.216	0.080	0.370
uv-11r	slightly orange-red	0.405	0.130	0.321
uv-18r	slightly red-orange	0.492	0.080	0.163
2606r	" " "	0.323	0.025	0.073
2613	" " "	0.660	0.100	0.152
2616	" " "	0.187	0.034	0.182

Niel, 1947). In consequence, under cool temperature conditions, it is highly probable that different color shades are brought about in different strains by different proportions in acceleration of the production of the rose-colored acidic pigments and of the orange-colored neutral pigments. As shown in Table, 4 however, the delicate variations in color shade of the warm-culture strains do not accord with those in $E(\lambda_{\max.})$ ratio, and are in general much more shifted toward the orange side than indicated by the numerical value of $E(\lambda_{\max.})$ ratio calculated. This discrepancy is perhaps due to the low rate of pigment production under warm conditions, especially to the extremely low production of the acidic pigments.

Conclusion and Summary

Change in colonial color caused in the low temperature cultures was investigated with seven variants and the parent strain of the yeast, *Torula rubra* Saito. All the strains examined differ from one another in development of colonial color at temperatures of 7–10°C, but such differences are markedly reduced in the cultures at 22–25°C. The methanol extracts from any of these strains have no characteristic absorption band, and their absorption spectra are not affected by changing the temperature at which the cultures were made. In the extracts from the cool cultures, either with alcoholic potassium hydroxide or with petroleum ether, the observed extinction values are greatly increased. However, the differences in colonial color shade of the strains are not comparable with those in extinction value at the wavelength of maximum absorption, $E(\lambda_{\max.})$, of either extract, but they are with the differences in ratio of $E(\lambda_{\max.})$ of the alcoholic hydroxide extract to that of the petroleum ether extract. This may suggest that under cool conditions the production of the components contributing to the absorption spectra, i.e., the rose-colored acidic pigments and the orange-colored neutral pigments, are differently accelerated in different strains. In contrast, under warm conditions, the colonial color shades of the strains do not accord with their $E(\lambda_{\max.})$ ratios, probably because of a low rate of pigment production, especially of an exceedingly low production of acidic pigments.

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ノコンギク属植物の核型分析 V*

藤原悠紀雄**

Yukio HUIWARA**: Karyotype Analysis in *Aster* V*

昭和 32 年 2 月 7 日受付

筆者(1),(2),(3),(4)は前 4 報において *Aster* 属 19 種, 7 亜種および 7 変種について核型分析を行い, 日本産 *Aster* は節により少しずつ核型を異にするが *Alpigenia* 節以外のものはいずれも極めて対称の核型をもつこと, また *Alpigenia* 節および北米種 *Aster* は染色体が小さく, 非対称の核型を示すことを明かにした。今回は北海道および樺太産の本属植物の核型を観察し, これらの植物とそれぞれ近縁の関係にある本州産植物の核型と比較研究したので報告する。

材料および方法

核型観察の方法は前 4 報におけると全く同じであって, 用いた材料は次の通りである。〔 〕内に示したものはそれぞれの植物と最も近縁と考えられる本州産の植物名である。

Aster glehni Fr. Schmidt エゾゴマナ

〔*A. glehni* Fr. Schmidt var. *hondoensis* Kitamura ゴマナ〕

A. tataricus L. var. *fauriei* Kitamura オクエゾシオン

〔*A. tataricus* L. シオン〕

A. ageratoides Turcz. subsp. *ovatus* Kitamura var. *yezoensis* Kitamura エゾノコンギク

〔*A. ageratoides* Turcz. subsp. *ovatus* Kitamura ノコンギク〕

A. dubius Onno ex Kitamura subsp. *glabratus* Kitamura et Hara var. *angustifolius* Hara アボイアヅマギク

〔*A. dubius* Onno ex Kitamura subsp. *glabratus* Kitamura et Hara ミヤマアヅマギク

結 果

1. エゾゴマナ *Aster glehni* Fr. Schmidt $2n=18$ 北海道虻田産 (Figs. 1, 5)

本種はゴマナ *A. glehni* Fr. Schmidt var. *hondoensis* Kitamura に比し葉の両面に細毛があり, 総苞が筒状や Δ 大形である点で区別される。体細胞染色体 18 個は大きさの順に 9 対に排列することができ, 着糸点はすべて submedian の位置にある。最大の染色体 1 対 (1, 2) のほか第 6 対 (11, 12) の染色体にもしばしば短腕に二次狭窄を認めた。しかしこのような小形の染色体における二次狭窄は不染部がや Δ 不明瞭であってゴマナにおいてもしばしば認められるので, 両植物において核型の差はないと考えられる。ゴマナおよびエゾゴマナは核型の上で既報の 2 倍種シロヨメナに近い。

2. オクエゾシオン *A. tataricus* L. var. *fauriei* Kitamura $2n=54$ 樺太原産栽培品 (Figs. 2, 7)

本変種はシオン *A. tataricus* L. に比し花期の早いこと, 頭状花がや Δ 大きいことなどで区別される。体細胞染色体 54 個は大きさと形とから 15 種類に分けられ, 大小 2 対の L^2E 染色体をもつ。着糸点は median および subterminal のものがそれぞれ 2 対ずつあるほかはすべて median に近い submedian である。本植物は染色体数および核型においてシオンと区別がない。

3. エゾノコンギク *A. ageratoides* Turcz. subsp. *ovatus* Kitamura var. *yezoensis* Kitamura et Hara $2n=36$ 北海道銭函産 (Figs. 3, 10; Table 1)

* Contributions from the Biological Institute, Kôbe University, Kôbe, No. 44

** 神戸大学生物学教室 Biological Institute, Kôbe University, Kôbe.

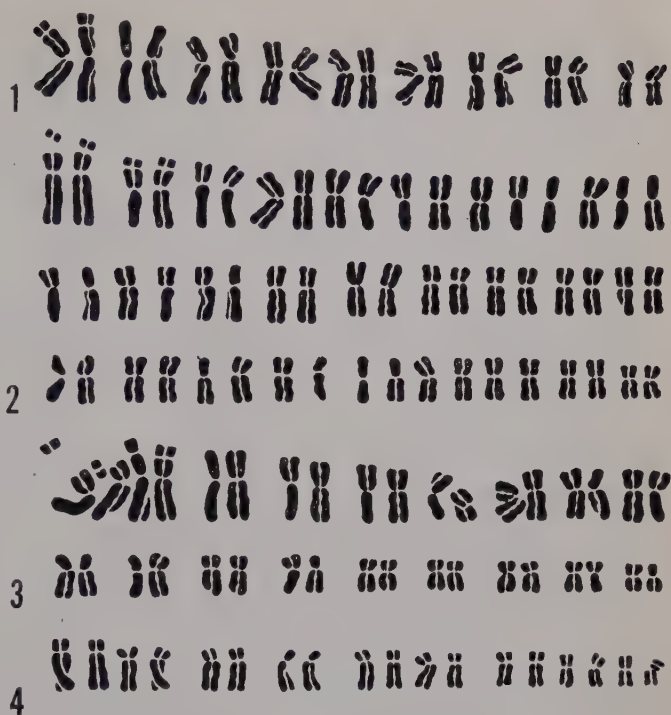
本植物は葉の中葉の下半部が急に狭まっている点で本州産のノコンギク *A. ageratoides* Turcz. subsp. *ovatus* Kitamura と区別される。体細胞において 36 個の染色体をもつ 4 倍体である。第 1 表に示すように最大の染色体は長さ 8.4μ , 最小の染色体は 2.4μ で長さの差が著しく, 最小の 1 対 (35, 36) が median であるほかは着糸点はすべて median に近い submedian の位置にあり, 対称の核型を示す。さきに報告した六甲山産のノコンギクに比し染色体は全体としてやや小形であるが, 核型は極めて類似してほとんど区別がない。L^{2E} 染色体は大小 2 対認められたが, 第 2 対の (3, 4) 二次狭窄は第 1 対のような明瞭な不染部を示さない。

4. アポイアヅマギク *A. dubius* Onno ex Kitamura subsp. *glabratus* Kitamura et Hara var. *angustifolius* Hara $2n=18$ 北海道アポイ山原産栽培品 (Figs. 4, 12)

本種は葉の幅狭く, 冠毛がやや長い点で本州高山のミヤマアヅマギク *A. dubius* Onno ex Kitamura subsp. *glabratus* Kitamura et Hara と区別される。体細胞染色体 18 個はいずれも小形であって 8 種類に区別される。核型はミヤマアヅマギクと一致し, 非対称の染色体が多い。

観察及び結論

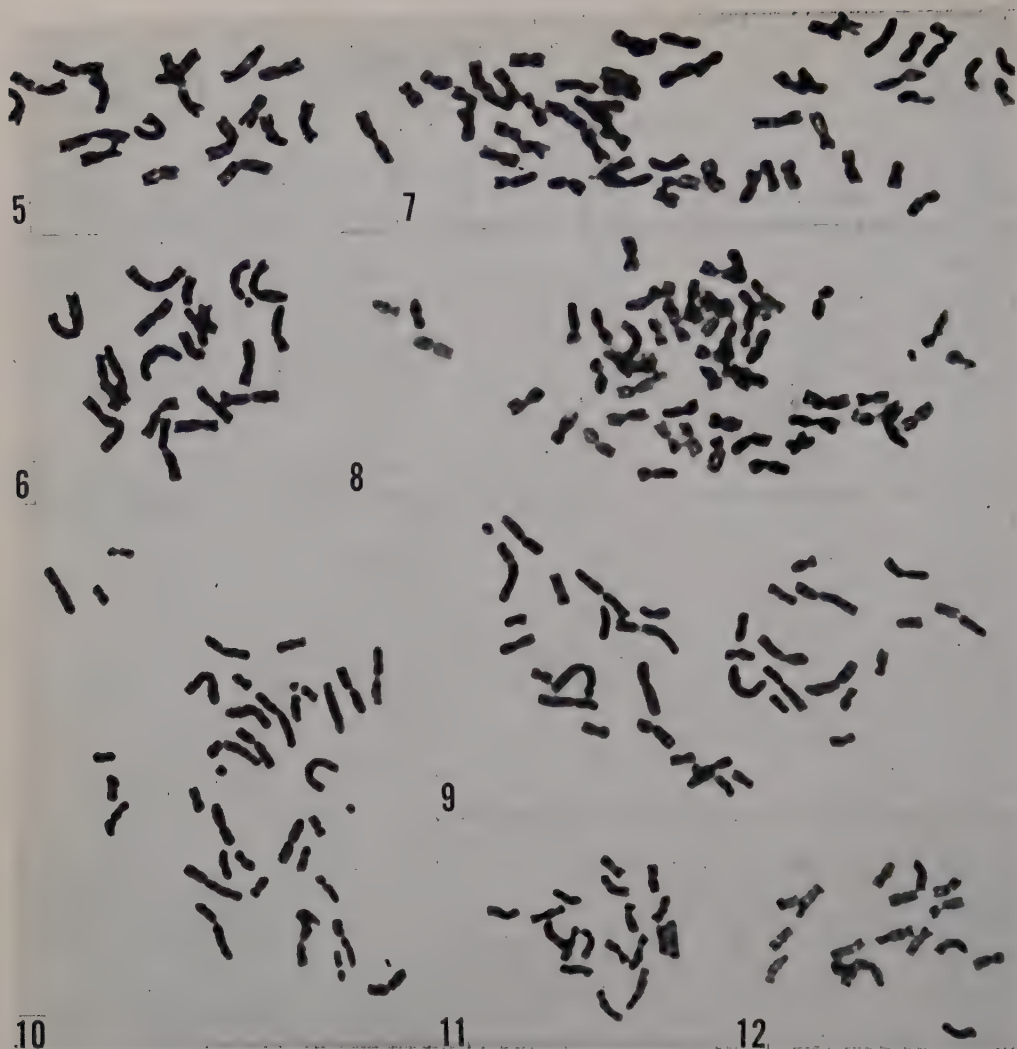
Aster 属植物のうち北海道および樺太の固有種であるエゾゴマナ, オクエゾシオン, エゾノコンギクおよびアポイアヅマギクは外部形態が僅かずつ異なるところから本州産のゴマナ, シオン, ノコンギクおよびミヤマアヅマギクとそれぞれ同一種の変種として区別される。しかし上の記載によって明かなように核型の上からは互に区別がなく, 北海道および樺太産の *Aster* と本州産の *Aster* との外部形態上の相違は極めてわずかの染色体の構造変化によるものか, または遺伝子変化による



Figs. 1-4. Somatic chromosomes of *Aster*. $\times 1800$.

1. *A. glehni*, $2n=18$.
2. *A. tataricus* var. *fauriei*, $2n=54$.
3. *A. ageratoides* subsp. *ovatus* var. *yezoensis*, $2n=36$.
4. *A. dubius* subsp. *glabratus* var. *angustifolius*, $2n=18$.

ものである。北村⁽⁵⁾によれば以上の 8 植物の所属する 4 種の *Aster* 即ち *A. glehni* Fr. Schmidt, *A. tataricus* L., *A. ageratoides* Turcz. および *A. dubius* Onno ex Kitamura はいずれも北方起原のもので中国, 満州およびシベリアに産することが知られている。これらの 4 種の植物のうち *A. dubius* を除く他の 3 種の分布は一方では満州より韓国を経て本州に伸び, 他方では樺太を経て北海道に伸び, それらの分布の拡大過程において分化し, 僅かずつの形態上の変化を生じたものであって津軽海峡が分布の境界となったものと考えられる。*A. dubius* は西日本には産せず, 北海道および本州中北部の高山にのみ見られるところから他の多くの高山植物と同じく千島, 樺太および北海道を経て南下したのと考えられ, アポイアヅマギクはアポイ山に隔離され残存種となったものと思われる。従って上述の大陸種がいずれも原型であって上の 8 植物の 2 つずつの共通の祖先と考えられる。



Figs. 5-12. Photomicrographs of somatic chromosomes of *Aster*, $\times 1500$. 5. *A. glehni* from Abuta, $2n=18$. 6. *A. glehni* var. *hondoensis* from Kamikôchi, $2n=18$. 7. *A. tataricus*, $2n=54$. 8. *A. tataricus* var. *fauriei*, $2n=54$. 9. *A. ageratoides* subsp. *ovatus* from Mt. Rokko, $2n=36$. 10. *A. ageratoides* subsp. *ovatus* var. *yezoensis* from Zenibako, $2n=36$. 11. *A. dubius* subsp. *glabratus* from Mt. Karamatsu, $2n=18$. 12. *A. dubius* subsp. *glabratus* var. *angustifolius* from Mt. Apoi, $2n=18$.

エゾゴマナ、オクエゾシオンおよびエゾノコンギクは比較的大きい染色体をもち、対称の核型を示すのに反し、アボイアヅマギクは染色体が小さく、非対称の核型を示す。また最大染色体と最小染色体との大きさの差はエゾノコンギクにおいて著しく、他の3種においては僅かである。染色体数および核型から判断するときエゾゴマナおよびアボイアヅマギクは2倍種であるが、オクエゾシ

オンは異質6倍種、エゾノコンギクは異質4倍種と考えられる。

御指導を賜っている広島大学下斗米教授並びに分類学上の御教示をいただいた京都大学北村教授に御礼申上げる。材料植物を恵与下さった東京大学附属日光植物園久保田秀夫氏に感謝の意を表わす。

Table 1. Measurements of somatic chromosomes in *A. ageratoides* subsp. *ovatus* var. *yezoensis*

Chromosomes	Length in μ	Relative Length	F %	Centromere
1,2	8.4=4.8+2.4+1.2	100	43	sm
3,4	7.2=4.2+1.8+1.2	86	42	sm
5,6	7.2=4.2+3.0	86	42	sm
7,8	6.0=3.6+2.4	71	40	sm
9,10	5.4=3.0+2.4	64	44	sm
11,12	5.4=3.0+2.4	64	44	sm
13,14	5.4=3.0+2.4	64	44	sm
15,16	5.4=3.0+2.4	64	44	sm
17,18	5.4=3.0+2.4	64	44	sm
19,20	4.2=2.4+1.8	50	43	sm
21,22	4.2=2.4+1.8	50	43	sm
23,24	3.6=2.4+1.2	43	33	sm
25,26	3.6=2.4+1.2	43	33	sm
27,28	3.0=1.8+1.2	36	40	sm
29,30	3.0=1.8+1.2	36	40	sm
31,32	3.0=1.8+1.2	36	40	sm
33,34	3.0=1.8+1.2	36	40	sm
35,36	2.4=1.2+1.2	29	50	m

Summary

- 1. The karyotypes of 4 species of *Aster* from Hokkaido and Saghalien are reported.
- 2. There can be found no difference between the karyotypes of the four taxa and those of the corresponding relatives in Honshu.

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本 会 記 事

毎日学術奨励金について

毎日新聞社から毎日学術奨励金（総額 300 万円）候補研究の募集について周知方並びに推薦の依頼がありましたので、会員各位の中で適当と思われる研究がありましたら、学会本部庶務幹事宛に 至急御連絡下さい。申請書提出期限は 7 月 31 日です。

借成会学術奨励金について

財団法人借成会から借成会学術奨励金（総額 150 万円）候補研究の募集について周知方並びに推薦の依頼がありましたので、会員各位の中で適当と思われる研究がありましたら、学会本部庶務幹事宛に 至急御連絡下さい。申請書提出期限は 7 月 31 日です。

本会名誉会員 R. Kolchwitz 博士は 1956 年 4 日 16 日
ベルリンにて 83 才の高令で死去されました。

ここに報告し謹んで深甚なる哀悼の意を表します。

日 本 植 物 学 会

光合成文献抄録集第三次募集

監 修 東京大学教授 田 宮 博

1956 年 1 月以降発行の内外刊行物から下記の包括範囲の欧文文献を抄録し各集 20 数編ずつ年に 9 集刊行しております。（著者アドレス入り）

光 合 成

化学合成及び関連酵素系

光週期性等光と代謝系との関係

クロロフィル等同化色素の生化学

6 月現在 第 11 集刊行済

第 12 集印刷中（バックナンバーあり）

申込方法 予約制、第 1 集から第 3 集迄 450 円、第 4 集以降 3 集毎に 400 円を申受けます（送料共）。

申 込 先 東京都文京区本富士町 1 東京大学理学部植物学教室内 物質代謝研究会
（振替 東京 72247 番）

Double-Leaf Formation in *Sesamum indicum* L.*

by Jun HANAWA**

堀 順**: ゴマの双生葉の形成について*

Received February 16, 1957

In a study reported in the previous paper (Hanawa and Ishizaki, 1953), it was found that the embryo of *Sesamum indicum* L. was a suitable material for investigating morphogenesis, and that the embryo which was deprived of seed-coat and divided by a longitudinal cut into halves was capable of growing, that is, the operation did not essentially prevent the growth of the seedling but the divided plumules regenerated normal shoots. Moreover, at the time of regeneration of new plumule, the first foliage leaves frequently fused side by side into one double-leaf.

Pilkington (1929) investigated regeneration of shoot apices of *Vicia faba* and *Lupinus albus* after decapitation, a median split or a prick of the apex. Snow and Snow (1935) cut the decussate apex of *Epilobium hirsutum* by a diagonal cut, and found that new apices were formed from both halves by regeneration. Similar cases were also exemplified by Ball in a series of his experiments (1948, 1950a, b, 1951, 1952, 1955).

The regeneration of the new plumule in *Sesamum* occurred in the same manner as reported by the investigators cited above. However, the formation of the double-leaf was never studied by them. The causes and the processes of the double-leaf formation are particularly investigated in the present experiments.

Material and Methods.

In the earlier stages of development, *Sesamum indicum* L. shows a decussate phyllotaxis, which, however, turns gradually into a spiral one. The first foliage leaves arise simultaneously on both sides of the apex in its intercotyledonary plane. The second pair of leaves is set in the plane of the cotyledons. The rest of the pairs decussates for several nodes, and then two members of a pair shift out of the same level so that the decussate arrangement is eventually lost in the upper part.

In the present experiment the positions of the opposite leaves of the first pair were frequently so moved on the same level as to unite together (Fig. 2).

* Supported by a grant from the Science Research Fund of the Ministry of Education.

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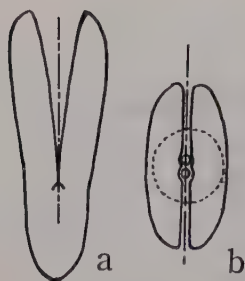


Fig. 1. Diagrams showing the plane of cut in reference to *Sesamum* embryo. a, side view. b, apical view.

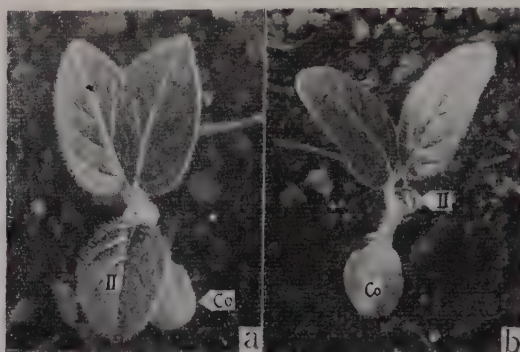


Fig. 2. Double-leaves of different grades of fusion. a, frequent form of double-leaf. b, a case showing two leaves at close approximation. II: the second foliage leaf, only one arising.

Incision of the shoot apex was made across the two leaf-primordia between the cotyledons (Fig. 1), following the technique reported in the previous paper (Hanawa and Ishizaki, 1953). Irrespective of that the split sometimes reached the hypocotyl or even as far down as the radicle of the embryo, a double-plant was obtained after successful regeneration of new shoots.

Embryos subjected to the operation were allowed to grow, at first on wet filter paper in Petri dishes, and when the seedlings grew about 2 cm high they were transplanted to soil.

The processes of regeneration of new apices and formation of double-leaves were observed daily under a binocular microscope, and at the same time histological preparations of the regenerating apices were made. The materials were fixed with F. A. A., sectioned and stained with Delafield's haematoxylin.

On the other hand, various types of the first foliage leaves developed from the halved plumules were recorded in order to obtain a crude idea of the frequency standard of the different types.

Development of the first leaves on the normal and the operated plumules

The processes of leaf development on the operated and the intact plumules were compared. Fig. 3 shows the differences somewhat diagrammatically. In the case of the normal intact seedlings, in order to have a clear view of the plumules, one of the cotyledons was removed. During the first day after sowing, leaf-primordia of the intact embryo showed enlargement as two tiny mounds. The mounds, i. e. leaf-primordia, grew separately on the opposite side of the shoot apex, and developed eventually into two opposite leaves (Fig. 3 a-d). In the operated embryos, various forms of the first foliage leaves ranging between double-leaf to normal one were found. On some halves of the plumules, leaves failed to appear entirely. In most cases,

one member of the double-seedling acquired a double-leaf, while the other obtained a normal leaf. In some cases both halves developed a double-leaf respectively. These various types are represented by the numerals in the left column of Table 1, in which 2 designates a double-leaf, 1 a normal leaf,

$\frac{1}{1}$ two opposite leaves, and 0 means no leaf. Consequently, 2–2 means that both of the regenerated plumules are provided with double-leaves. Numerals in the middle and the right columns show numbers of individuals observed 17 and 27 days after the operation respectively. Differences of the number between the two columns are due to death of some seedlings or delayed development of some leaves.

When the double-leaf is formed, the two half leaf-primordia, which were strictly opposite to each other across the apex at the time of cutting, are found in adjacent positions on the outside of the new shoot, by the time a double-leaf is definitely recognized by a binocular microscope (Fig. 3 e, f). When the leaves are fused, the apex naturally comes to be hidden from outside (Fig. 3 g, h).

The transverse sections through the apices of the normal and the regenerated shoots make anatomical situations clear (compare Fig. 4a with e–h). Fig. 4a illustrates the normal leaf-arrangement in an unoperated seedling. Fig. 4e–h represent serial sections of a regenerated shoot with a double-leaf, showing the convergence of the leaves toward outside of the apex from the original position. Fig. 4b–d represent the serial sections of an individual in which the position of leaves is the same as normal, in spite of splitting. In this case the plumule may have failed to be split or may have been split on extremely lateral side.

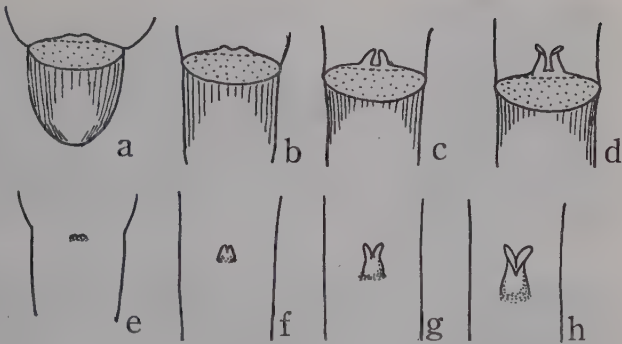


Fig. 3. Leaf development illustrated somewhat diagrammatically. a–d, normal development of the opposite leaves. e–h, development of the double-leaf on the halved plumule.

Table 1. Numbers of various forms of the first leaves developed on the operated plumules.

Forms	17 days after the operation	27 days after the operation
2–2	8	8
2–1	37	34
2–0	13	8
1–1	13	14
1–0	17	5
0–0	3	1
$\frac{1}{1}$ –0	8	7
$\frac{1}{1}$ –1	6	4
$\frac{1}{1}$ –2	2	3
$\frac{1}{1}$ – $\frac{1}{1}$	0	2
Total	107	86

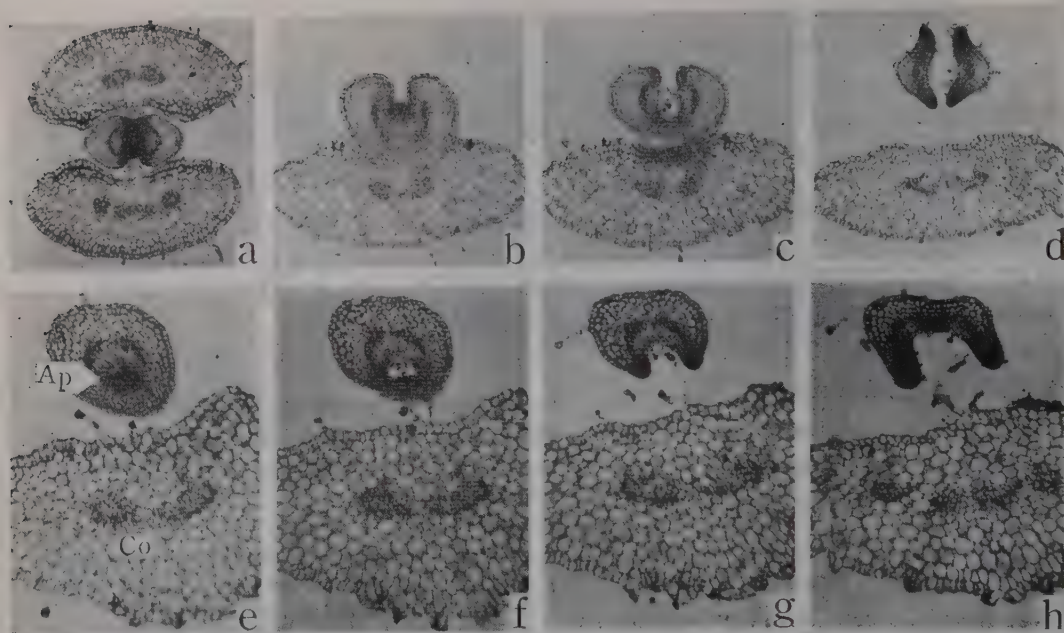


Fig. 4. Transverse sections through the apical region, showing the leaf arrangement. a, decussate arrangement in normal seedling, grown 4 days. b-d, serial sections of an individual with opposite leaves formed on the operated apex, grown 10 days. e-h, serial sections of an individual with a double-leaf, grown 7 days. Ap: apex, Co: cotyledon. a, $\times 29$. b-d, $\times 40$. e-h, $\times 54$.

From these observations it is suggested that the formation of the double-leaf has a close bearing to the processes of shoot regeneration.

Shoot Regeneration

During the first day after the operation, the plumule does not show any recognizable growth, except the fact that, in sections, cell division within the uppermost part of the cut causes a slight bulge of the halved plumules above the subjacent part of the hypocotyl, where cell division has not begun yet (Fig. 5b). Since the cells injured by the microscalpel are disintegrating, the surface of the cut is now lined with underlying uninjured cells.

During the second day after the operation, further cell division within the plumule makes the bulge more conspicuous (Fig. 5c). Cell division beneath the wound surface spreads toward lower levels, and the cut surface is covered by the densely-staining remains of the dead cells. By the third day after the operation the regeneration of the shoot apex is almost completed (Fig. 5d).

The regeneration of shoot is apparently brought about by the mass of the meristematic cells formed by the cell divisions in the plumule. The new apex is situated in the central part of the mass, while the edge of the mass which was originally a central region of the plumule makes the flank meristem (Fig. 5d).



Fig. 5. Longitudinal sections, showing shoot regeneration. a, vertical split through the median plane of the embryo immediately after operation. b, apical region of the cut, 1 day after the operation. c, regenerating apex, 2 days after the operation. d, apex almost completing regeneration, 3 days after the operation. e, the first foliage leaf, appearing on the cut side of the apex, 4 days after the operation. f, the same, 7 days after the operation. co: cotyledon, p: plumule, ap: new apex. a, $\times 50$. b, $\times 260$. c, $\times 48$. d, $\times 125$. e, $\times 100$. f, $\times 75$.

The above facts can be interpreted as indicating that the new apex is reorganized from the cells which were to be lateral region if the original apex were left intact. The first foliage leaves, on the other hand, arise on the cut edge which now lies on the flank of the new apical meristem.

Discussion

The regeneration of the apices following the longitudinal split has been investigated by several workers. It was found that the new apex grew out from the uninjured surface of the original growing point, and in no case did regeneration of the apex take place from the wound surface (Pilkington, 1929). Ball (1948) found that when the apex of *Lupinus albus* was subdivided into quarter-segments by vertical incisions through the center of the apical meristem, the approximate center of the quarter, which was a lateral portion of the original apex, became the tip of the new apex, the cells adjacent to the center of the original shoot apex failing to become the point of regeneration of the new apex. That a new shoot apex develops from the flank of the original shoot apex was also shown in the other experiments, in which the central initials of the apex were cut out by a wedge-shaped

sector (Ball, 1950a, b), or a small panel of the flank meristematic tissue was separated by two vertical cuts (Sussex, 1952). The same situation is also obtained in the present experiment.

On the basis of the above knowledge, the formation of the double-leaf may be explained in the following manner.

The relative positions of the first leaf-primordia in reference to the shoot apex change as the apex grows bigger (Fig. 6a). In other words, at the beginning, two lines connecting the center of the new shoot apex and the centers of respective leaf-primordia can be considered practically to be at 180° . However, as the growing point increases its size, it bulges out toward outside carrying the apex further out which, in turn, makes the angle between the above two lines narrower. Consequently, although the leaf-primordia remain at the same spots, their relative positions in reference to the shoot apex as a whole become closer together as the growing point becomes larger (Fig. 6b).

Snow and Snow (1937) showed that in *Epilobium* with decussate phyllotaxis, the youngest leaf-primordia (P_1) were displaced, by the application of hetero-auxin, toward the auxinated part so as to decrease the divergence angles. They consider

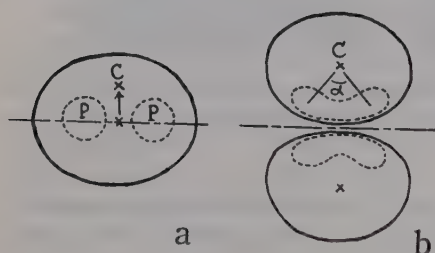


Fig. 6. Diagrams illustrating the displacement of the apex center (a), and the relative approximation and the union of the leaf primordia (b). c: apex center, p: leaf-primodium, α : divergence angle.

that under the influence of auxin, the P_1 s were to some extent dedifferentiated and determined anew. However, if it can be assumed that Snow and Snow might have applied an excess amount of hetero-auxin to suppress the growth, the auxinated part in their material and the wound surface in the author's experiment will suffer from the same distortion to make the divergence angles smaller, and the explanation offered to the present experiment will be applicable to the result of Snow and Snow too.

In *Sesamum* seedling, the two leaf-primordia, which have approached, eventually fuse together during their growth. Concerning this point, there still seems to remain some gap to be explained between a mere fact of spacial approximation of the structures and their fusion into one. This should be clarified by further investigation.

Summary

The plumule of the embryo of *Sesamum indicum*, which has a decussate shoot apex, was split by a vertical incision across the two primordia of the first pair of leaves. When the operated embryo was allowed to grow, these two members were displaced to the side of the incision of the apex and fused into a double-leaf. The process of the double-leaf formation can be explained in connection with the shoot

regeneration, as follows. The halved plumule regenerates a new shoot by the formation of a new growing point on the lateral side of the original apex. As the new growing point grows bigger, the relative position of the first leaf-primordia in reference to the whole stem becomes closer together, and eventually two leaf-primordia fuse together into a double-leaf during their growth.

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Growth of the Rhizoid and Behaviour of the Nucleus in *Dryopteris erythrosora*

by Yukio KATO*

加藤幸雄*: ペニシダにおける仮根の成長と核の行動

Received April 13, 1957

When the fern spore is cultured on the Knop's solution, the rhizoid and protonema appear out of the exine membrane. The protonematic cell, as a rule, contains a large number of chloroplasts, and it divides and elongates actively. On the contrary, no chloroplasts are usually found in the rhizoidal cell which only elongates without cell-division. That is, if the growth phases are classified into two, cell division and cell elongation, only one of these phases, cell elongation, is observed in the case of the rhizoid of *Dryopteris*. The elongation of rhizoid is just like to that of pollen tube. It has been believed that the vegetative nucleus of pollen tube has some rôle in the tube elongation. Bishop and McGowan (1) and Iwanami (3) suggested, however, that tube nucleus does not play a direct rôle in the tube elongation. Is there any relation between the growth and behaviour of nucleus, if it is assumed that the elongation of rhizoids is same with that of pollen tubes from the viewpoint of growth? In order to throw light on this point, some experiments here reported have been done.

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Material and Methods

The spores of *Dryopteris erythrosora* were mainly cultured in the 1/5 dilute solution. The culture of spores was, sometimes, carried out on an agar medium. The petri dishes, 5 cm in diameter, were filled with 10 c.c. Knop's solution or Knop's agar-medium. The media containing indole-3-acetic acid, naphthalene acetic acid, colchicine, sodium phosphate, etc. were also applied. About 15 days after sowing, germinating spores were put on a slide, and fixed or unfixed ones were investigated under the ordinary or phase contrast microscope. The material was fixed and stained with acetocarmine solution. According to this method, only the nucleus stains clearly. Whole length of rhizoid, the distance from the tip of rhizoid to the nucleus, the distance from the spore surface to the nucleus, the change of the nuclear shape affected by the chemicals in the media and the ramification of rhizoids were recorded in some details.

Results

1. Nuclear shape.

The rhizoidal nucleus in the Knop's solution is about $2.9-4.0 \times 0.25-0.5 \mu$ in size, and characteristic spindle-like, ellipsoidal or convex lens-like in shape (Figs. 1a-c), while the nucleus in the embryonic cell of protonema is usually round. Therefore, nuclear differentiation accompanied with cellular differentiation can be observed. In both stained and living materials, the nucleus of the rhizoidal cell is easily observed. In the 2% sodium phosphate solution

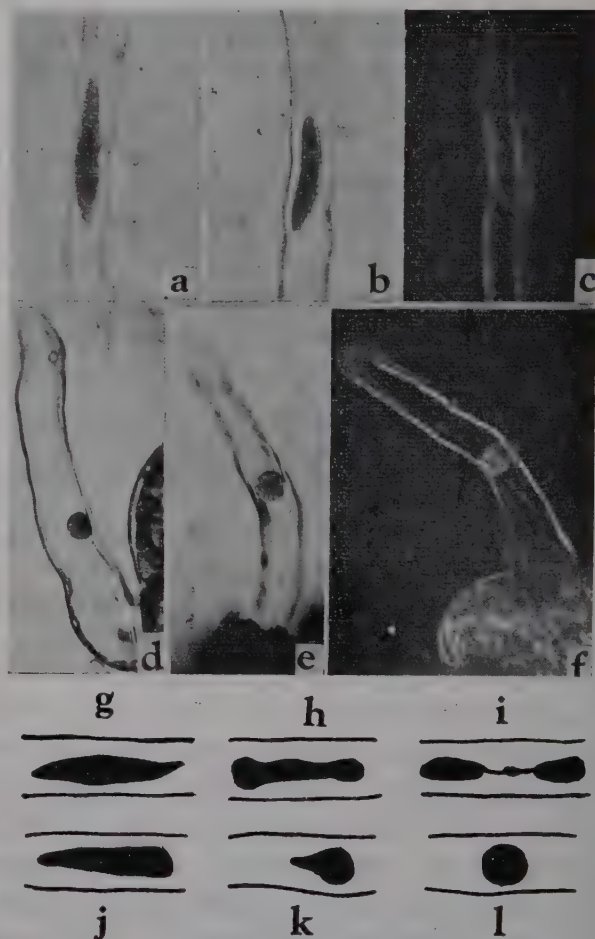


Fig. 1a-l. Nucleus of rhizoid and the change of nuclear shape.

a-b, spindle-shaped nucleus of rhizoid, fixed and stained with acetocarmine solution. Knop's solution. c, living state of rhizoidal nucleus, photographed by the use of the phase contrast microscope. Knop's solution. d-e, round nucleus of rhizoid, fixed and stained acetocarmine solution. 2% NaH_2PO_4 solution. f, living state of rhizoidal nucleus, photographed by the use of the phase contrast microscope. 2% NaH_2PO_4 solution. g-l, process of transformation from spindle-shaped to round nucleus.

the nuclear shape changes considerably. That is to say, the nucleus tends to be transformed into a round shape (Figs. 1d-f). The nuclear diameter is about $0.8-1.0\ \mu$ in this case. This change is obviously reversible. The process of nuclear change is shown in Figs. 1g-l. The nucleus becomes to be extremely slender filamentous in the solution containing indole-acetic acid or naphthalene acetic acid. In addition, triangle, heart-shaped or irregular shaped nuclei were also observed in these media.

2. The division of rhizoidal nucleus.

In order to induce the division of rhizoidal nucleus, NaH_2PO_4 , Vitamin B_1 , C, colchicine, sodium adenosine triphosphate, chloralhydrate, indole-acetic acid, naphthalene acetic acid, sucrose, glucose, adenylic acid, nicotinic acid, triodebenzoic acid, sodium phyrophosphate, asparagic acid etc, were tested. Amitotic figures and dump-belled nuclei were frequently observed in these solutions, but a rhizoid having two nuclei was never found. Amitotic figures may be induced by the change of nuclear shape, as mentioned above. It seems to be probable that the differentiating rhizoid nucleus, at least in *Dryopteris*, does not divide.

This is not true in the case of *Osmunda*. In *Osmunda japonica*, the rhizoidal nucleus divides even in the Knop's-agar medium (Kato, in press). The fact that auxin

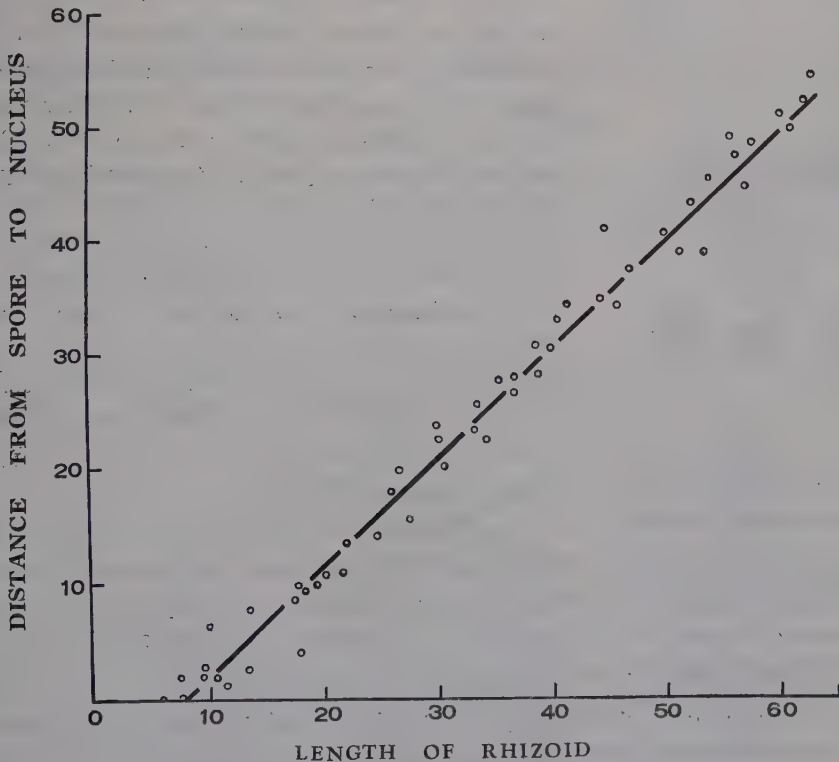


Fig. 2. Relation between distance from the spore surface to the nucleus and the length of rhizoid.

is ineffective for the induction of the division in differentiated rhizoidal cells of *Dryopteris erythrosora* must be noticed.

3. The number of rhizoids.

Indole-acetic acid and naphthalene acetic acid make increase the number of rhizoids. The number of rhizoids per spore in a very early stage of germination is only one with a few exceptions in the case of Knop's solution, while it is usually two in the case of the other medium containing monogen (detergent) and it varies from one to four in the case of the medium containing indole-acetic acid. Naphthalene acetic acid prevents the formation of rhizoids from the spore, but rather promotes the formation of lateral rhizoids from the protonema (Kato, in press). When the dormant spores are treated by radioactive cobalt (total dose, 415.4r), germinating spores with two or three rhizoids were frequently observed.

4. The relation between the length of rhizoids and the position of nuclei.

Figure 2 shows the relation between the length of rhizoids and the distance from the spore surface to the nucleus. As shown in the figure, the relation is exhibited by a straight line. This line shows that the distance from the tip of rhizoid to the nucleus is always constant (about $9-10\mu$). Such constancy is ascertained also in the case of the spore with two rhizoids (Fig. 3b). However, the nucleus is seldom present in the tip (Fig. 3c) or is not found at any part of the considerably long rhizoid (Fig. 3d).

The lateral rhizoids are resulting from an unequal division in the protonematic cell (Fig. 4). The distance from the tip to the nucleus increases abruptly, and later holds constant value. This fact shows that the nucleus does not dislocate, until the length of rhizoids becomes to be about 7μ . As soon as the rhizoid elongates up to 7μ , the nucleus moves from place to place.

As the rhizoid grows, the increase of distance from the tip to the nucleus becomes smaller, while the distance from the spore surface to the nucleus becomes larger (Fig. 4). Although the velocity of movement of nucleus does not, in the strict sense, coincide with the elongation rate, the tendency to coincide holds true always. Finally, it is concluded that the constancy is found not only in the case of rhizoid from the spore but also in that of the lateral

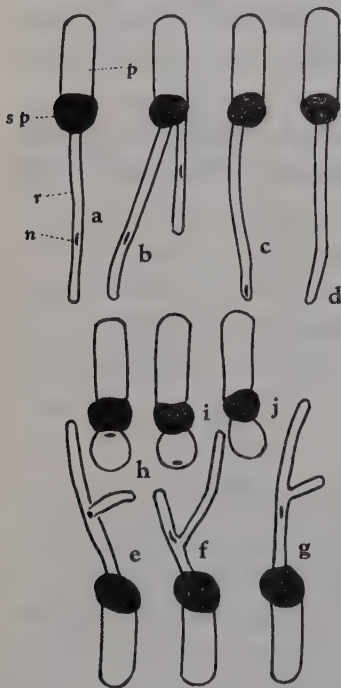


Fig. 3. a-j. Position of the nucleus and elongation of the rhizoid. sp—spore, p—protonema, r—rhizoid, n—nucleus, a-d, rhizoids in the Knop's solution. a, normal rhizoid. b, spore having two rhizoids. c, nucleus present in the tip. d, spore which the nucleus is invisible. e-g, ramification of rhizoids in the colchicine solution. h-j, swelling of rhizoids in the indole-acetic acid solution.

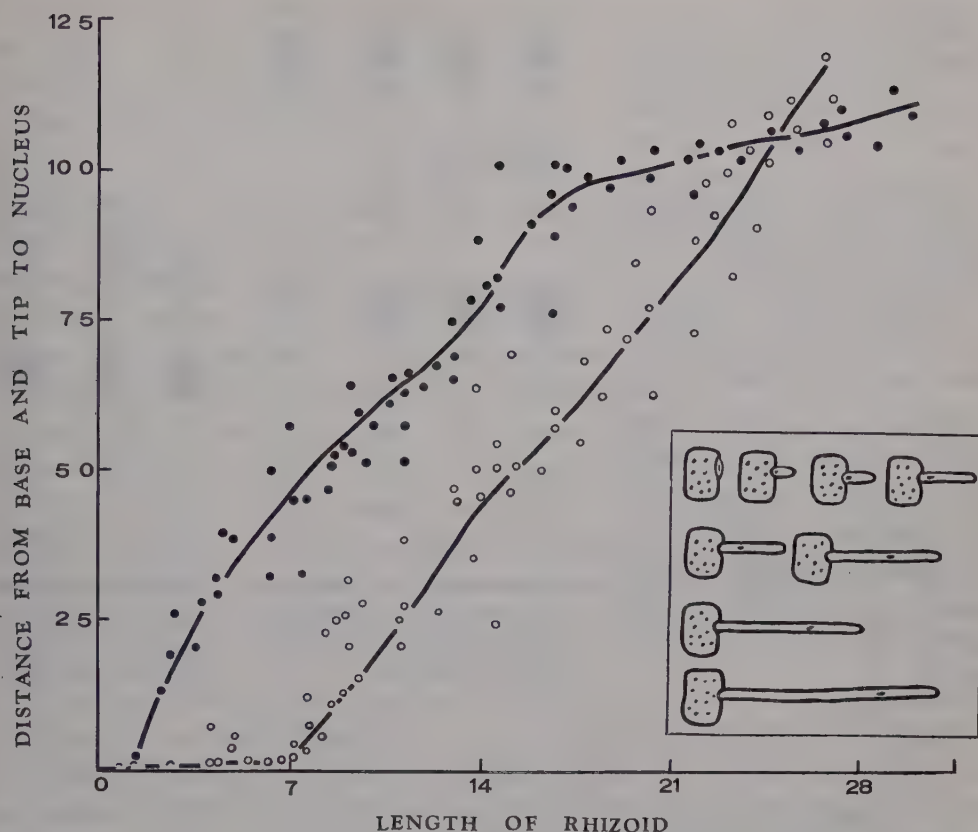


Fig. 4. Relation between length of the lateral rhizoid and distance from spore surface and tip to the nucleus. Black circles and white ones show the distance from the base of protonemal cell to the nucleus and from the tip to the nucleus, respectively. Schematic figures in the square show elongating process of lateral rhizoids and position of nuclei.

rhizoid from the protonema in the early stage of germination. This suggests that the nucleus has a rôle in the elongation.

Indole-acetic acid induces the swelling of rhizoids, and inhibits their growth (Figs. 3h-j). In this case, the constancy of distance mentioned above is not recognizable. Usually the nucleus takes its random position in the rhizoid. In the spores cultured in the medium containing 0.01 % colchicine, the ramification of rhizoids occurs markedly. About 25 days after sowing the spores with ramified and smooth rhizoid were 60 and 40 %, respectively. Even spores having seven branches were often observed (Figs. 5a-d). In order to investigate the rôle of nucleus for the elongation, agar culture medium was applied to this study. Figures 5e-h and 6a-c show the spores drawn every day. Both the branches of rhizoidal cell without nucleus and the original cell with nucleus may elongate well (Figs. 6a-c). The branches appear even from the proximal portion containing no nucleus (Figs. 5e-h).

From these experiments presented here, it may be concluded that(1) the nucleus is not indispensable or requisite for the elongation, and that (2) the elongation occurs chiefly in the apical zone of rhizoids.

At the stage of filamentous protonema, the distance from the tip to the nucleus increases as the rhizoidal elongation proceeds. The distance was about 15-25 μ in a stage of protonema investigated. It was found that the rule of constancy can not be equally applied to the young and old prothallia.

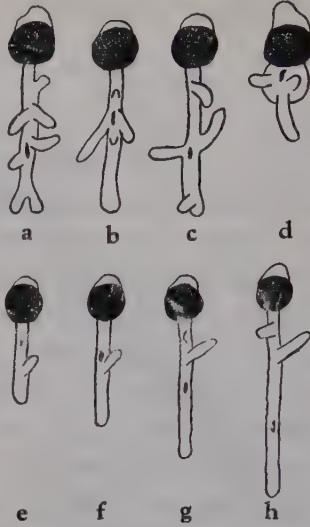


Fig. 5. a-h. Ramification of rhizoids reveals by colchicine treatment. e-h, ramification and elongation of the rhizoid, sketched every day.

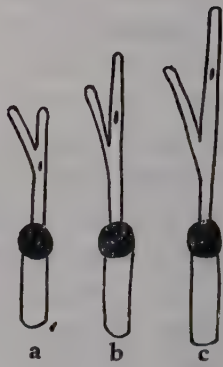


Fig. 6. a-c. Ramification of rhizoids induced by colchicine. a-c, elongation of rhizoid, sketched every day.

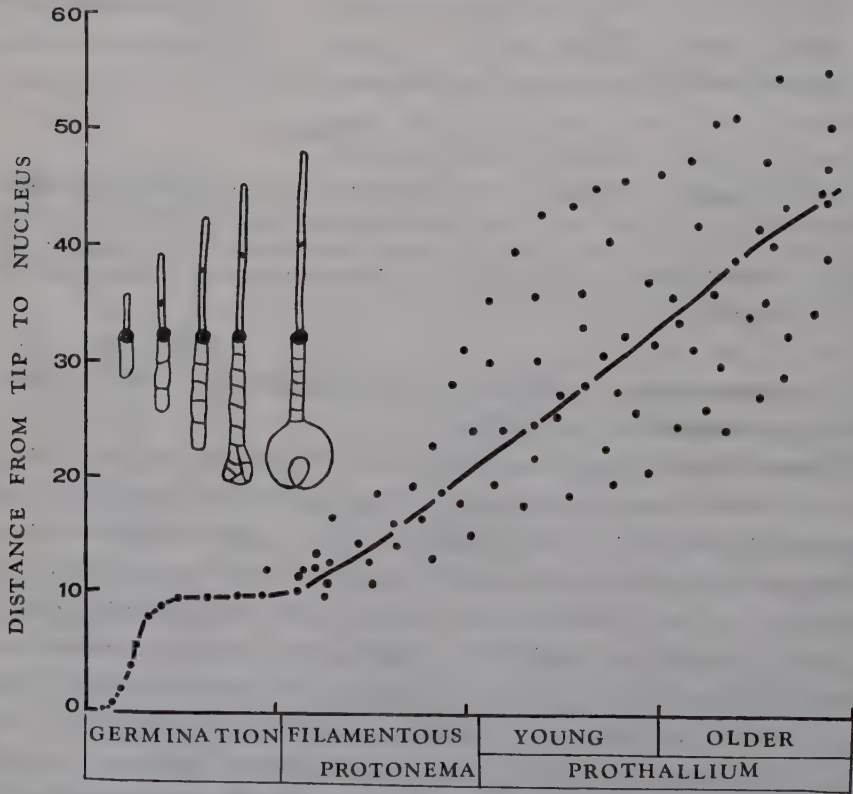


Fig. 7. Relation between the developmental stage of prothallium and distance from the tip of rhizoid to the nucleus. Schematic figures show the developmental process of prothallium and the position of nucleus.

There is a great variability of the distance in these stages (Fig. 7). Generally speaking, the distance from the tip to the nucleus is larger in old stages than in young stages. For instance, it varies from 13 to 70 μ in a stage of prothallium. The relation is shown in Figure 7.

Discussion

The literatures concerning the rôle of the nucleus in cellular differentiation of plants have been summarized in a recent monograph of Bünning (2). In fern, a marked polarity of the plasm configuration is observed in the protonematic cells. Beside the observation of the plasm configuration, the shape and position of the nucleus and the qualities of the chloroplasts within the different cells were especially observed in the protonematic cells by Reuter (7).

As to the shape of the nucleus, the spherical and oval forms, as well as the spindle-shaped one in cells developed under certain conditions are observed. These qualities of the nuclei and plastids are in correlation with the configuration of plasm. In general, the nucleus is oval in young cells and spindle-shaped in the elongated cells. In the rhizoid of the present material, the spindle-shaped nucleus was observed in the Knop's solution. Thus, the cellular differentiation may be accompanied by the nuclear differentiation.

It is considered that the position of nucleus in the cytoplasm may be changed by the surface tension, the position of vacuole and the protoplasmic density of a cell. The cytoplasm of a rhizoid is abundant in and near the apical portion. The nucleus is usually located in the most active metabolic region. Hence, the nucleus of root hair and of pollen tube are located in and near apical portion. Tanaka (8) have recently reported that the pollen tube nucleus plays an important rôle during the growth of pollen tube. The distance between the tube tip and the nucleus was kept nearly constant during the growth of the tube except in certain stage, and also, in the bifurcated pollen tubes, the position of the nucleus had a certain relation to the growth of the tube. He suggested that the nucleus acts as a center of synthesis of cytoplasm in some way. However, this does not necessarily mean that the nucleus is indispensable for elongation of the tube-like structure. In fact, Bishop and McGowan (1) and Iwanami (3) described that the vegetative nucleus may not act directly on the elongation of pollen tube. In the development of foliar sclerids, translocation of the nucleus of initial cell occurs in certain early stages, giving rise to the protuberances which soon elongate to form ramification (5). Kitamura (5) mentioned that there are found no instances in which the nucleus translocates into the elongating branches and that the nucleus play no rôle for the elongation of protuberances. These suggestions can be applied to the rhizoid elongation in fern. Yamazaki (9) reported that the uneven big rhizoid is formed by the colchicine treatment, contrary to the flat smooth rhizoid in the control medium. However, the relation between the growth of rhizoid and the behaviour of nucleus were not investigated.

Summary

1. The quality and behaviour of nucleus have been studied in the rhizoid of *Dryopteris erythrosora*.
2. Very striking change of nuclear shape has been observed in a medium containing 2 % sodium phosphate, and this change was reversible.
3. In *Dryopteris*, the cell-differentiation may be accompanied by the nuclear differentiation.
4. It has been discussed that the nucleus of rhizoids is not indispensable for the elongation.

I wish to express my thanks to Dr. T. Shimamura for his cordial guidance during the work.

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Electron-microscopical Study on Fine Structures of Diatom Frustules XVI

by Haruo OKUNO*

奥野春雄*: 電子顕微鏡による珪藻殻微細構造の研究 XVI

Received June 3, 1957

Chaetoceros Eibenii Grunow (Text-fig. 1; Pl. VI, Figs. 1a-c), Ikari, Bot. Mag. Tokyo, 39: 52, Figs. 1, 2 (1925); Mills, Index Diat. p. 385 (1933); Cupp, Bull. Scrips Inst. Ocean. 5: 106, Fig. 61 (cf. p. 7, Fig. C8) (1942); Desikachary, Mikrosk. 9: 174, Figs. 25, 27, 28 (1954)

Syn. *Chaetoceros borealis* Bailey, Helmcke and Krieger, Diat. Elektr. Bild, 2: 9, pls. 120-122 (1954)

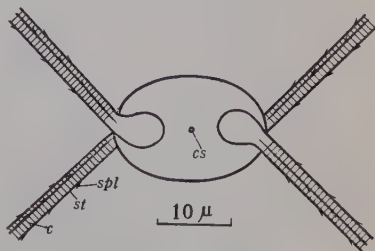
L.M.S.¹⁾ Cells cylindrical, broadly elliptical in valve view, about 39μ long and about 27μ broad. Valve surface slightly convex, with an inconspicuous central spine (*cs*). Mantle (*m*) moderately low, but distinct. Setae (*st*) with swollen bases (*bs*),

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1) Light-microscopic structure.

arising from a little inner of the apical ends. One of the setae of a valve curved outwards nearly parallel to the apical plane, and the other nearly parallel to the transapical plane (Text-fig. 1). Setae armed with minute spinules (*spln*) on the corners, and with fine transverse costae (*c*) about 13–15 (according to Ikari and Hustedt, about 23) in $10\ \mu$ (Pl. VI, Fig. 1b). **E.M.S.**²⁾ Materials in formalin solution, after washed in water, were observed by their direct preparations in the electron microscope.

Valve surface with delicate radial, anastomosing ribs (*r*) $100\text{--}150\text{ m}\mu$ broad, about 5 in $1\ \mu$. Holes (*h*) on the valve surface round, sparse, about $100\text{--}200\text{ m}\mu$ in diameter. Central spine of the valve rounded and hollow, about $1\ \mu$ long and about $1.5\ \mu$ in diameter. Mantle (*m*) ribless, with somewhat dense holes about 2–3 in $1\ \mu$ (Figs. 1a, c). Intercalary bands with longitudinal rows of ribs about 5 in $1\ \mu$, and



Text-fig. 1. Valve view of a frustule of *Chaetoceros Eibenii*, showing directions of two pairs of setae. *c*, Costa. *cs*, Central spine. *spl*, Spinule. *st*, Seta.

with sparse holes. Setae hollow, with very thin lateral wall. Base of setae (*bs*) swollen, with radial rows of rectangular, incomplete loculi (*il*) about $1\ \mu$ long and $0.6\text{--}0.8\ \mu$ broad. Loculi close outwards with finely porous sieve membranes, and open inwards almost freely with narrow marginal inner membranes. Outer sieve membranes with transverse rows of round sieve pores about $60\text{--}80\text{ m}\mu$ in diameter. Rows of the sieve pores about 7–8 in $1\ \mu$ (Fig. 1c). Setae four-sided, with transverse costae (*c*) about 13–15 in $10\ \mu$. Between each two costae, with about 4 transverse rows of holes about $60\text{--}70\text{ m}\mu$ in diameter (Fig. 1b). Fine structure of the seta is almost the same as that of *Chaetoceros pervianus* (cf. Okuno, Bot. Mag. Tokyo, 69: 191, Pl. 8, Figs. 5–8. 1956).

Habitat: Marine plankton. Saigô Bay, Oki Island, Shimane Prefecture (Okuno, No. m1028. Oct. 1955).

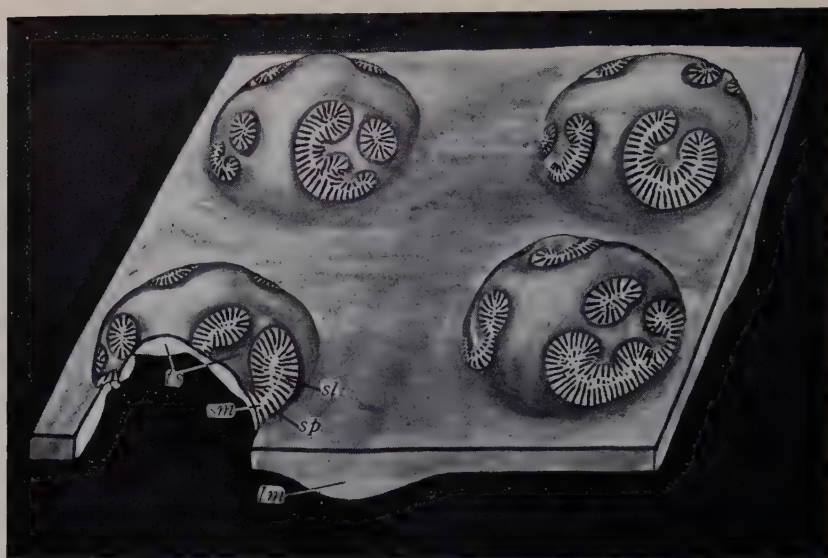
Cocconeis stauroneiformis (W. Smith) Okuno, comb. nov. (Text-fig. 2; Pl. VI, Figs. 2a–c)

Syn. *Cocconeis scutellum* Ehrenberg var. *stauroneiformis* W. Smith, Synop. Brit. Diat. 1, Pl. 30, Fig. 34 β (1853); Hustedt, Kieselalg. 2: 339, Fig. 792 (1933); Mills, Index Diat. p. 437 (1933)

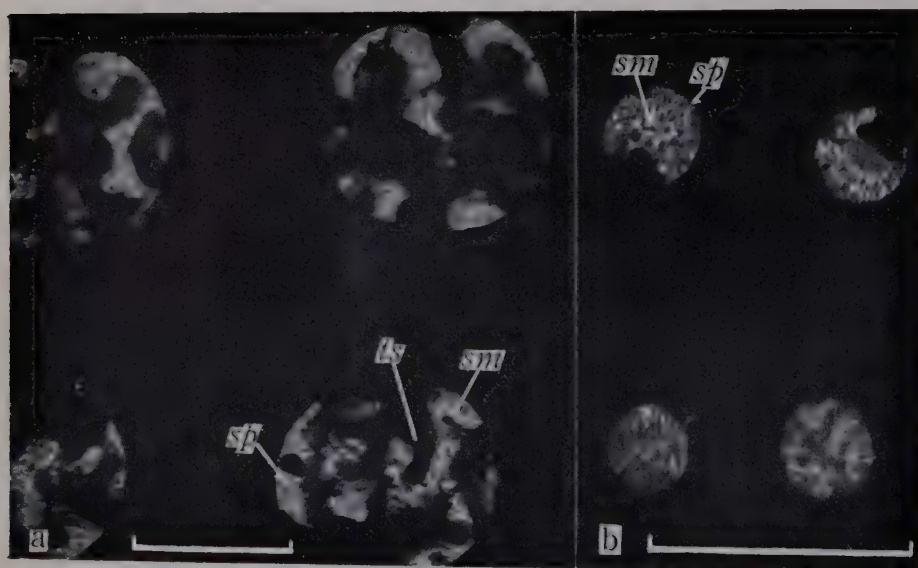
E.M.S. Materials, after one week's cleaning in concentrated hydrochloric acid, were washed in water, and observed by their formval-preparation in the electron microscope.

Valves elliptical, about $12\text{--}20\ \mu$ long and about $10\text{--}15\ \mu$ broad. Upper valve (Figs. 2a–u, b, c) with radiating rows of subrectangular loculi about $9\text{--}10\ \mu$ in $10\ \mu$. Pseudo-

2) Electron-microscopic structure.



Text-fig. 2. Diagrammatic representation of a portion of the lower valve of *Cocconeis stauroneiformis*, showing fine structure of loculi. *lm*, Rudimentary lateral membrane. *sl*, Secondary loculus. *sm*, Sieve membrane. *sp*, Sieve pore. *ts*, Thickening of sieve membrane. (cf. Pl. VI, Fig. 2a-l.)



Text-fig. 3. *Cocconeis scutellum*. a, Portion of an upper valve. Note the dendriform thickenings (*ts*) or ingrowths of the sieve membrane (*sm*). b, Portion of a lower valve, showing the sieve membranes without thickenings. *sp*, sieve pore. (a, b, Electron micrographs. Scales: 1 μ .)

raphe narrow linear. Loculi in each radiating row about 11-12 in 10μ . Loculus subrectangular about $0.7-1.0\mu$ square, closes outwards with a closing membrane and opens almost freely inwards with a large, rounded opening about $0.4-0.6\mu$ in diameter. Inner membrane of the loculus narrow, marginal. Loculus is divided by netveined thickenings (*ts*) or ingrowths inside the sieve membrane into 4-6 (at the margin of the valve, into 6-9) rounded secondary loculi (*sl*). (Compare *Cocc. scutellum* in Text-fig. 3a, in which the thickenings are dendriform!) Sieve membranes (*sm*) of the secondary loculi have delicate radial slit-like sieve pores (*sp*) about 45 in 1μ . Lower valve (Text-fig. 2; Fig. 2a-1) very thin, with a linear raphe about $40m\mu$ broad. Axial area linear, about $500m\mu$ broad. Central area dilated to a fascia reaching to the margin. Valve surface with radiating rows of holes with rudimentary lateral membrane (*lm*). Submarginal rim somewhat thickened, smooth, about $600m\mu$ broad. Holes subrectangular, about 10 in 10μ in each radiating row, close outwards and open inwards. The outer closing membranes have crossed thickenings (*ts*) with freely ending or anastomosing branches, leaving more or less kidney-shaped or lunate membraneous areas. Of the thickenings of the closing membranes, the transverse ones are robust, and these are visible even with the light microscope as delicate transverse striae between each two costae (cf. Hustedt, l. c. Fig. 792). The kidney-shaped area of the closing membrane is perforated by linear slit-like sieve pores (*sp*) as those of the closing membranes of the upper valve. At the margin of the valve, with a ring of a little larger, rounded or elliptical loculi in which the thickenings of closing membranes are netveined as in the loculi of the upper valve. Sieve membranes of the marginal loculi too, have delicate linear slit-like sieve pores. The loculi near the apical ends too, have netveined thickenings inside the sieve membrane (Fig. 2a-1).

Helmcke and Krieger published two electron micrographs of "raphenlose Schale" of *Cocconeis scutellum* Ehrenberg forma in their Diat. Elektr. Bild, 2, Pl. 156, with explanation in text p. 12 as follows: "Die Kammern der raphenlosen Schalen besitzen kompliziert gebaute Siebmembranen (T. 156 u.). Am Rande sind die Sieböffnungen strichförmig, wie das für alle bisher untersuchten *Cocconeis*-Arten charakteristisch ist. Im Zentrum der Siebmembranen sind die Poren kürzer und weiter voneinander entfernt." But according to my research, the upper valve (raphenlose Schale) of *Cocc. scutellum* and its varieties always showed the complex loculus with dendriform or netveined ingrowths or thickenings inside the sieve membrane (cf. Text-fig. 3a; Pl. VII, Figs. 1e; Okuno, Bot. Mag. Tokyo, 63: 101, Pl. 3, Figs. 6', 6", 1950). And the incomplete loculus of the lower valve (raphen Schale) showed a delicate sieve membrane without such ingrowths or thickenings (Text-fig. 3b; Pl. VII, Fig. 1f). Of the Helmcke-Krieger's micrographs, owing to the lack of explanation, I could not understand enough whether their upper and lower electron micrographs were obtained from the same valve or from two different valves. If their two micrographs were of the same "raphenlose Schale", the fine structure of the sieve mem-

brane of the upper valve (raphenlose Schale) of their forma is distinctly differs from that of the type species and its varieties hitheto researched by me. Their lower electron micrograph shows rather the similar fine structure as that of the lower valve (raphen Schale) of *Cocc. scutellum* and its varieties researched by me. Thus, if their two micrographs were obtained from two different valves, the lower one probably represents a lower valve.

Cocc. stauroneiformis was hitherto described as a variety of *Cocc. scutellum*. But, it differs distinctly from *Cocc. scutellum* not only in light-microscopic feature, but also in electron-microscopic structure as shown in Table 1. And I regard these two diatoms as two different species.

Table 1. Comparison between *Cocconeis stauroneiformis* and *C. scutellum*.

	<i>C. stauroneiformis</i>	<i>C. scutellum</i>
Length of valve (μ)	12-20	20-60
Breadth of valve (μ)	10-15	12-40
Upper valve		
Fascia	+	-
Rows of loculi in 10 μ	9-10	5-8
Thickening of sieve membrane	netveined	dendriform
Lower valve		
Rows of loculi in 10 μ	10	7-9
Thickening of sieve membrane	cross-shaped, with branchlets	-

Helmcke and Krieger published an electron-microscopic diagram of a frustule of *Cocc. placentula* (Helmcke and Krieger, l. c. Pl. 155. 1954). In their diagram, the upper valve is shown provided with a raphe and the lower valve with a pseudoraphe. Up to the present day, many of the diatomists (Heurck, 1881; Cleve, 1894; Pantocsek, 1903; Dippel, 1904; Meister, 1912; Hustedt, 1916; Boyer, 1927; Hanna, 1932) noted that in *Cocconeis*, the upper valve provided with a pseudoraphe and the lower valve with a true raphe. In spite of the description of these diatomists, by cell division, it may occur that the lower valve of a mother cell with a true raphe can reproduce a daughter opposite lower valve with a pseudoraphe. But to my sorry, I have not yet seen any publication in which such a reproduction is reported as a fact. On the other hand, Hustedt (1930, 1933) used the technical terms "Raphenschale" and "raphenlose Schale" without explaining which of them is the upper or the lower valve. Thus, if Helmcke-Krieger's diagram is showing the true positions of the raphe and pseudoraphe, it is an interesting fact of the structure of upper and lower valves in *Cocconeis*. In my present electron microscopy, I could not conclude which view of Helmcke and Krieger or of the others is true.

And in the present paper, I wrote, according to many descriptions, a valve with a true raphe as the "lower valve" and a valve with a pseudoraphe as the "upper valve".

Habitat: Marine; attached to *Sargassum* sp. Minato, Awaji Island, Hyôgo Prefecture (Okuno, No. m1032. Aug. 1955. Leg. Y. Funakoshi).

Cocconeis scutellum Ehrenberg var. **parva** Grunow (Pl. VII, Figs. 1a-f), Heurck, Synop. Diat. Belg. p. 133, Pl. 29. Figs. 8, 9 (1881); Cleve, Synop. Nav. Diat. 2: 170; Hustedt, Kieselalg. 2: 338, fig. 791 (1933); Mills, Index Diat. p. 436 (1933); Proschkina-Lavrenko, Diat. Black Sea, p. 181, Pl. 8, Figs. 1, 2, (1955)

E.M.S. Materials in formalin solution, after washed in water, were observed by their formval-preparation in the electron microscope. Valves elliptical, about $10\text{--}28\mu$ long and about $7\text{--}19\mu$ broad. Upper valve with a pseudoraphe about 1μ broad. Loculi on the upper valve arranged in radiating and slightly arcuate longitudinal rows. Radiating rows about 5-7, in small valves to 10 in 10μ ; longitudinal rows about 6 in 10μ (Figs. 1a, b). Loculus usually subrectangular, closes outwards by the sieve membranes (*sm*) with netveined thickening (*ts*) and opens inwards almost freely with a large rounded opening. The sieve membrane is divided by netveined thickenings or partitions into about 7-10 micropores which representing the secondary loculi (*sl*). Sieve membranes of the secondary loculi have extremely delicate radial slit-like sieve pores (*sp*) about 50-60 in 1μ (Fig. 1e). Lower valve (Figs. 1c, d) with a narrow linear raphe about $10\text{m}\mu$ broad. Axial area linear, about $400\text{m}\mu$ broad, somewhat thickened. Valves with radiating rows of round pores about $200\text{--}400\text{m}\mu$ in diameter, and the rows about 13-17 in 10μ . Valves very thin near the axial area and grow somewhat thicker to the margin. And, the pores in the thin part usually take the form of holes without distinct lateral membranes, and at the margin take the form of incomplete loculi with rudimentary lateral membranes. Sieve membranes (*sm*) both of holes and incomplete loculi, have marginal, radial slit-like sieve pores (*sp*) about 30-40 in 1μ , and scattered rounded sieve pores in the center (Fig. 1f). The sieve membrane is similar in its structure with that of *Cocc. diminuta* and *Cocc. scutellum* forma shown in Helmcke and Krieger, l. c. Pl. 154, Fig. upper right and Pl. 156, Fig. lower (1954). Further, Helmcke and Krieger published two pairs of electron-stereomicrographs of *Cocc. scutellum* in their Pl. 47. The valves shown in their plate are about 20μ long and about $11\text{--}14\mu$ broad, much smaller than those of *Cocc. scutellum*, and the sieve membranes of the upper valve (Figs. upper row) show clearly the netveined thickenings which are, according to my research, not characteristic to *Cocc. scutellum*, but to the present var. *parva* (cf. Text-fig. 3a). Their electron micrographs named *Cocc. scutellum* in Pl. 48 too, show similar fine structure. And I regard their electron micrographs in Pls. 47, 48 are not of *Cocc. scutellum*, but probably represent the present var. *parva*.

Habitat: Marine; attached to *Sargassum* sp. Minato, Awaji Island, Hyôgo

Prefecture (Okuno, No. m 1032. Aug. 1955. Leg. Y. Funakoshi).

Mastogloia angulata Lewis³⁾ (Pl. VII, Figs. 2a-c), A. Schmidt, Atlas Diat. Pl. 187, Figs. 4-11 (1893); Hustedt, Kieselalg. 2: 465, Fig. 885 (1933); Mills, Index Diat. p. 898 (1934)

L.M.S. Valves elliptic, about 60-70 μ long and about 28-30 μ broad, with more or less produced ends. Raphe straight. Axial area very narrow, central area narrow elliptical. Loculi of septum 4-5 μ broad, about 3 in 10 μ , the median two largest. Loculi of the valve arranged in slightly radiating rows, about 9-10 in 10 μ , in each row loculi about 8-9 in 10 μ (Fig. 2a).

E.M.S. Material in formalin solution, after washed in water, were observed by their direct preparation in the electron microscope.

Loculi in central part of the valve usually hexagonal, each closed outwards by a porous sieve membrane (*sm*) and opens almost freely inwards. Inner membranes (*im*) of the loculi very narrow, and the rounded inner opening (*o*) of loculi are very large. The central area of the outer sieve membranes about 300-600 $m\mu$ in diameter, usually circular, finely porous with round sieve pores (*sp*) about 20-40 $m\mu$ in diameter. Sieve pores usually arranged in a marginal ring. Loculi along the axial area somewhat elongated transversely, and in each loculus sieve pores are arranged in a marginal, elliptic or subangular ring (Fig. 2b). Transverse rows of hexagonal loculi end near the margin of the valve in double rows of small incomplete loculi (*mgl*) with rudimentary lateral membranes (*lm*) and each double rows consist a transversely elongated compound loculus with rectangular lateral membranes which probably a little lower than those of the hexagonal loculi in the central part of the valve. Sieve membranes of the marginal incomplete loculi about 250-600 $m\mu$ in diameter, and scattered with round sieve pores (Fig. 2c). At the apical ends of the valve too, double rows of incomplete loculi consist compound loculi as at the margin.

Habitat. Marine, littoral. Minato, Awaji Island, Hyôgo Prefecture (Okuno, No. m991, 1020. Aug. 1954, 1955).

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* On the genus *Mastogloia*, the electron-microscopic fine structures of the following three species were reported: *M. Braunii* (Helmcke and Krieger, Diat. Elektr. Bild, 1: 14, Pls. 57, 58, 2: 13, Pl. 159. 1953, 1954), *M. fimbriata* (Okuno, Bot. Mag. Tokyo, 66: 6, Pl. 1, Figs. 3'-3'', 66: 123, Pl. 1, Fig. 12. 1953), *M. Smithii* (Helmcke and Krieger, l. c. 2: 13, Pl. 160. 1954).

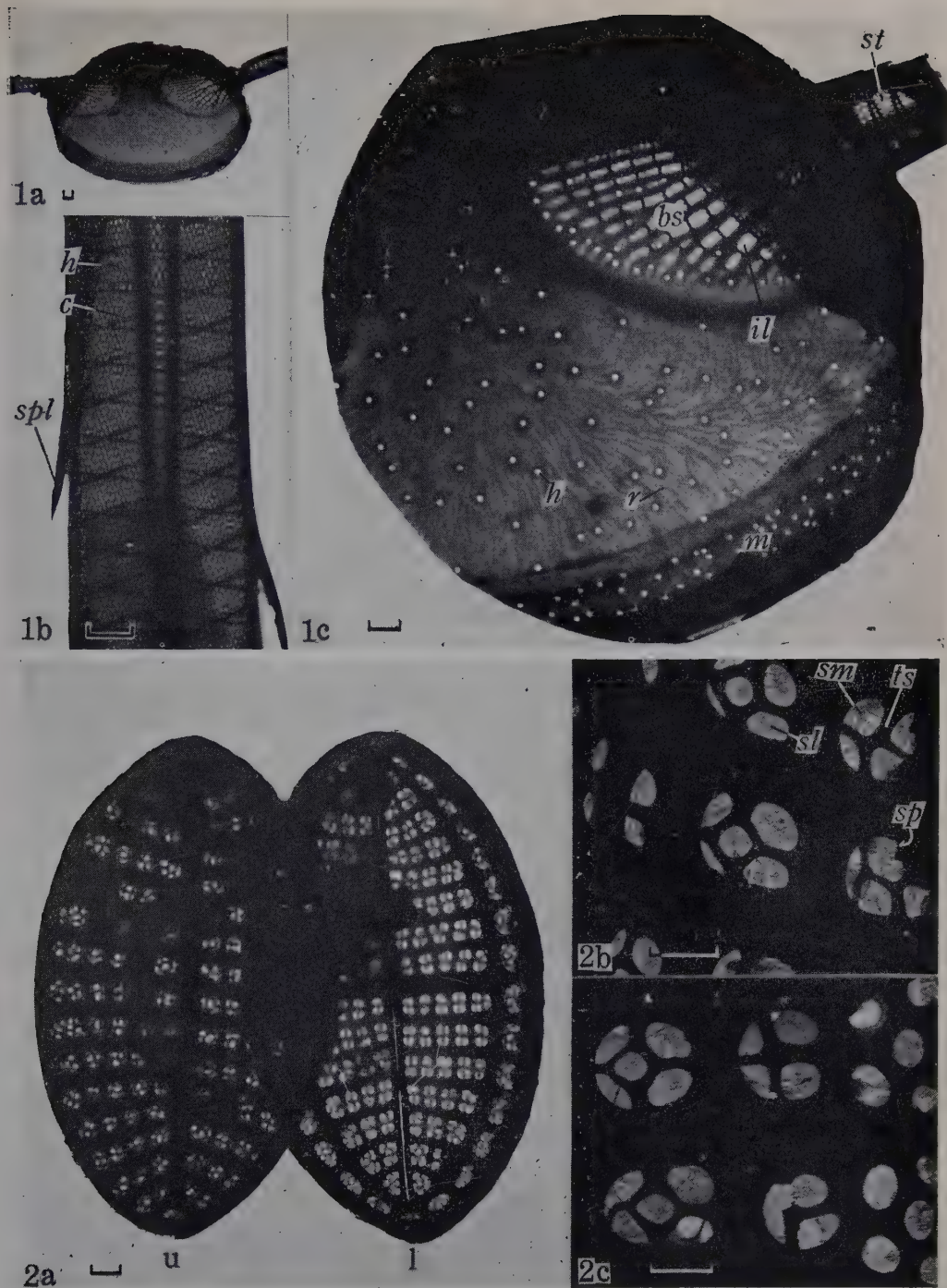


Plate VI. Figs. 1a-c, *Chaetoceros Eibonii*. a. Single valve. b. Section of a seta. c. Portion of a valve. 2a-c, *Cocconeis stauroneiformis*. a. Upper (u) and lower (l) valves. b. c. Portions of an upper valve, showing fine structure of loculi. bs, Base of seta. c, Costa. h, Hole. il, Incomplete loculus. m, Mantle. r, Rib. sl, Secondary loculus. sm, Sieve membrane. sp, Sieve pore. spl, Spinule. st, Seta. ts, Thickening of sieve membrane (lateral membrane of secondary loculus). (1a-2c, Electron micrographs. Scales: 1 μ .)

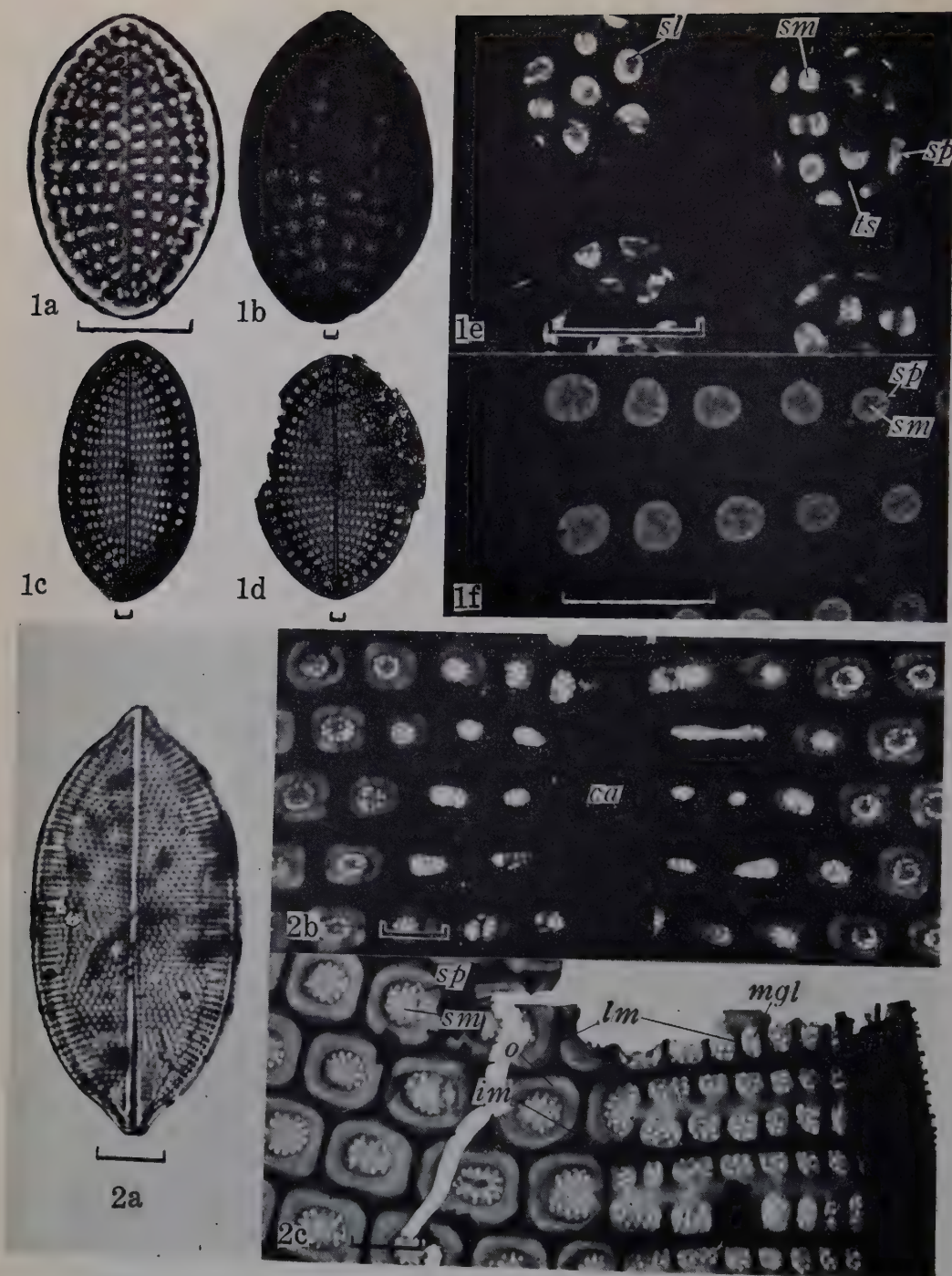


Plate VII. Figs. 1a-f, *Cocconeis scutellum* var. *parva*. a. b. Upper valve. c. d. Lower valve. e. Portion of an upper valve. f. Portion of a lower valve. 2a-c, *Mastogloia angulata*. a. Single valve. b. Central portion of a valve. c. Marginal portion of a valve. *ca*, Central area. *im*, Inner membrane. *lm*, Lateral membrane. *mgl*, Marginal loculus. *o*, Opening of inner membrane. *sl*, Secondary loculus. *sm*, Sieve membrane. *sp*, Sieve pore. *ts*, Thickening of sieve membrane (lateral membrane of secondary loculus). (1a, 2a, Light micrographs. Scales: 10 μ . 1b-f, 2b, c, Electron micrographs. Scales: 1 μ .)

日本産竹類の前出葉に関する形態学的研究

薄 井 宏*

Hiroshi USUI*: Morphological Studies on the Prophyll of Japanese Bamboos.

昭和 32 年 3 月 20 日受付

緒 言

本邦竹類（ササ類を含む）の前出葉について、その形態学的研究は殆んどなされていない。たゞ竹内（1932）により概略が述べられているにすぎず、この外にはまとまった研究はない。

前出葉（prophyll）とは“植物体の枝、及び花部の枝の基部に生ずる退化的な葉を云う”（Arber 1925, Goebel 1933）。一般に双子葉類では側生の位置に 2 枚、単子葉類では主軸と側軸との間に 1 枚の前出葉を生ずるがしばしば例外が見られる。単子葉類の前出葉の横断面には、通常両側に 2 つのりゅう骨（keel）を有し、その各々に 1~3 本の管束を有する点、及び葉身と葉鞘とに分化せず、やゝ透明な膜状である点で上部の尋常葉と形の上で区別される。

この二側稜型（two-keeled form）の前出葉の解釈については、19 世紀初頭以来論議の多い所である。その一つは、前出葉の両側に見られる 2 つのりゅう骨及びその各々に存在する管束は本来 2 枚の葉が向軸面でゆ合したもので、各々のりゅう骨と管束は別々の 1 枚の葉の主脈の部分であるとする解釈である。Turpin（1819）が最初にこの二元説（double origin）をとなえて以来現在に到るまでこの説は支持されてきた（Ruter 1918, Troll 1937）。

これに反し前出葉は 1 枚の向軸側に生ずる器官であって、進化の途上その主脈を消失し、左右 2 本の管束は側脈であるとする説もある。（Roepert 1824, Cosson 1854, Billot 1855）。

其後 Bugnon（1921）、Guilland（1924）、Arber（1925）等は上記 2 つの説に反対し、前出葉は 2 つ

のりゅう骨の中どちらかが主脈にあたる 1 枚の葉であって、向軸面に生ずる器官ではなく、側生の器官であると主張した。

最近 Blaser（1944）は単子葉類の前出葉に関する論文の結論で、前出葉は尋常葉と本質的に区別され得る独特の器官ではなく、単に葉にすぎないとし、側生の場合もあり、向軸面に主脈を有する場合もあって一定せず、前出葉の性質についての論議は無益であると強調している。

これに対する筆者の考えは、後述の如く前出葉は 2 つのりゅう骨の中どちらかが主脈にあたる一枚の葉であって、側生の器官と解釈する。

前出葉によって竹類の分枝が規定され、腋芽におけるその配列型式は系統を論ずる上に、又属の再検討にも適用できる可能性が強い。そこでこの論文では竹類の芽の横断面における前出葉の配列型と分枝法を観察し、前出葉に対して厳密な考察を行った。

材 料 と 方 法

連続切片を作って観察した材料は次の通りである。*Sasa nipponica* Makino, *Sasa paniculata* Makino, *Sasa kurilensis* Makino et Shibata, *Pleioblastus Chino* Makino, *Pleioblastus pygmaea* Mitford, *Shibataea kumasasa* Makino, *Pyllostachys nigra* Munro var. *nigra*, *Phyllostachys heterocycla* Matsum. var. *pubescens* Ohwi, *Phyllostachys bambusoides* Sieb. et Zucc., *Semiarundinaria yashadake* Makino, *Sinobambusa tootsik* Makino.

以上の種類のごく若い時の芽をブアソ液で固定し、パラフィン埋没による連続切片を作った。ミ

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クロトームによる切片の厚さは 10μ である。染色は主としてヘマトキシリンのみとし、ライトグリーンを併用した場合もある。

上記の種の前出葉を総察した結果、次の4型に分つことができる。

前出葉の各型

1. ササ型 (Sasa Type)

この型の前出葉はいずれも両側によく発達したりゅう骨を有し、その中に1本づつ管束をもって

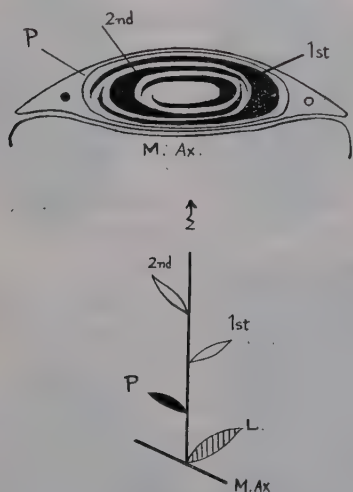


Fig. 1. The bud of Sasa Type, and the diagram of the branching.

P, prophyll; 1st, the first foliage leaf; 2nd, the second foliage leaf; M. Ax., main axis; L, a leaf on the node of main axis; the black leaf shows the prophyll and the white leaf shows the foliage leaf.

いる (Fig. 1)。前出葉に包まれた内部の葉は正しく $1/2$ の葉序に交互に配列している。これらの葉の間には前出葉は見られず、従ってこの型の前出葉をもつササ類では1節から1本の枝しか打たない。竹類の中でこの型に属するものは *Sasa* 属のみである。

2. ネザサ型 (Pleioblastus Type)

この型の芽においては、外側の前出葉の内側に第2番目の前出葉が見られ、又第1葉の内側に第3番目の前出葉が見られる (Fig. 2)。従って稈節における枝の数は少なくとも3本はみられ発育の

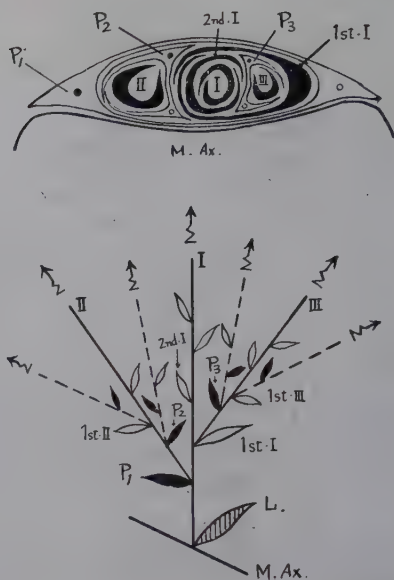


Fig. 2. The bud of Pleioblastus Type, and the diagram of the branching.

P_1 , the outer prophyll; P_2 , the second prophyll in the axil of the P_1 ; P_3 , the third prophyll in the axil of the 1st foliage leaf; 1st. I, the 1st foliage leaf of the first branch; 2nd. I, the second foliage leaf of the first branch; M. Ax., main axis; L, a leaf on the node of main axis.

よい芽では、第2、第3の前出葉の中に更に前出葉を生じて枝をうち1節から7~9本の枝を生ずる。これらは何れも基本的には上述の型式のくりかえしであるにすぎない。

この型に属するものは、*Pleioblastus*, *Semiarundinaria*, *Sinobambusa* の三属である。

3. オカメザサ型 (Shibataea Type)

オカメザサの芽は他の竹類に見られない独特の型を有する。それは外側の前出葉が通常の二側稜型ではなく向軸面の中央部で左右2枚の葉の重なりが見られる点にある (Fig. 3)。

この事実は日本産竹類の芽においては唯一の型式で、この論文で始めて紹介される事実である。又後述のとおりこの事実から前出葉の解釈上極めて重要な点が明らかにされた。

枝のうち方は、主軸に対して第1の枝を生じ、この第1枝の下部の2枚の葉の葉腋に第2、第3の枝 (II, III) を生じ、この各々は更に第4、第

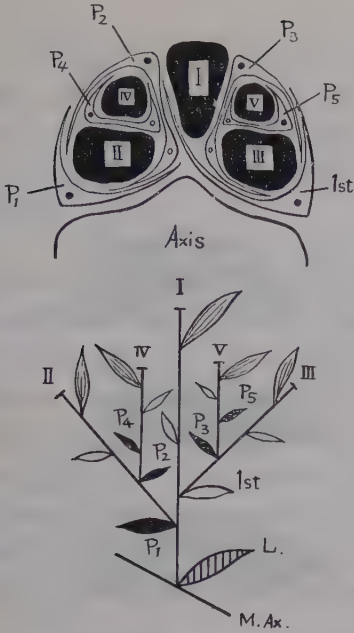


Fig. 3. The bud of *Shibataea* Type, and the diagram of the branching.

Note especially the outer pair of leaves, the left one is a prophyll (P_1) and the right is considered to be a foliage leaf (the 1st foliage leaf of the first branch).

5 (IV, V) の枝を背軸側にうって、合計5本の枝が1節にある。この分枝の数は極めて安定しており、ネザサ型のような数の不定さは見られない。

この型の芽を有するものは本邦では *Shibataea kumasasa* のみである。

4. マダケ型 (*Phyllostachys* Type)

マダケ類の節からは左右に開いた2本の枝と、背軸側に更に細い枝を1本うち、一般には2~3本の枝が見られる (Fig. 4)。外側の前出葉 (P_1) は二側稜型であるが、第2番目の前出葉は通常背軸側に管束を有し、向軸側のりゅう骨は発達がわるく管束のない場合が多い。

枝のうち方は、主軸に対して第1の枝を生じ第2番目の前出葉 (P_2) の葉腋より第2の枝 (II) をうち、更に (P_3) の葉腋に第3番目の枝を生ずる (Fig. 4)。このような分枝の型式は単軸分枝から仮軸分枝に移行する中間の型式であって第1の枝の片側だけにみ次々と枝をうつのが特徴である。

この型に属するものは *Phyllostachys* 属のみである。

考察及び結論

A. 前出葉の本質

以上に述べた個々の前出葉の形の上で注目すべき点は次の通りである。

1. 外側の前出葉はオカメザサを除いて何れも二側稜型であり、左右のりゅう骨に管束がみられる。りゅう骨の大きさには大小があり、内部の第1葉 (尋常葉) の主脈は大きい方のりゅう骨と向い合せに位置する。
2. 内部の前出葉では一般にりゅう骨の大小が明らかで、大きい方に管束を有し、小さい方には管束がない場合が多い。
3. 二側稜型の外側の前出葉に於いて、背軸面におけるへりの重なりは、背軸面の中央ではみられず、必ず小さい方のりゅう骨に寄った所で重なっている。但しこの重なりは芽の基部においてはゆ合して筒状である場合が多く、とりわけササ類では上部まで筒状である。

以上の事実から竹類の二側稜型の前出葉は *Arber* 等も指摘したように一枚の葉であると見ることができる。そしてその主脈は主軸と枝との面

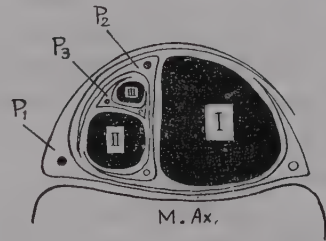


Fig. 4. The bud of *Phyllostachys* Type, and the diagram of the branching.

Note especially the sympodial branching.

には直角の位置、即ち側生の位置を占める。又、前出葉に特有のりゅう骨の成因は前出葉の位置にくる葉が内外の圧力によって空所の形に変形させられるだけのことでありといえる。

以上により前出葉は枝の上の第 1 葉で、これまで第 1 葉とみなした内部の尋常葉は枝の上の第 2 葉に相当することになる。

B. オカメザサの前出葉の解釈

オカメザサの外側の前出葉は一見して分離した 2 枚の葉のように見える。二元説の立場から云えば、この 2 枚の葉は明らかに二元説を裏付ける有力な証拠と見ることができる。即ち本来このような 2 枚の前出葉のへりが向軸面でのゆ合によって通常の二側稜型に進化したものと解釈できるからである。又この場合なぜ外側の前出葉のみが分離して、内部の第 2、第 3 の前出葉は二側稜型を示すのか、これに対する筆者の解釈は次の通りである。

即ち、外側の 2 枚の葉の中で第 2 枝を包んでゐる葉 (P_1) が前出葉にあたり、これと重なって第 1 枝と第 3 枝を包む葉はその位置と形の上からは前出葉と同じに見えるけれども、これは考察で述べた如く、枝の上の第 1 葉と解すべきものである。従ってその分枝の型式を図示すればネザサ型と基本型には変りはない (Fig. 5)。ただオカメザサでは第 1 番目の前出葉が二側稜型でないこと、又枝の上における分枝のくりかえしが一定している点が異っている。

C. 二側稜型の前出葉の成因

オカメザサの前出葉の解釈を更に押し進めると、二側稜型の成因も説明することができる。即ち Fig. 5 においてオカメザサの外側の前出葉が発達して、これと重なる内部の葉を包み (Fig. 5, A→B→C) そのへりは背軸面の中央より Fig. 5 の如く右に寄った所で重なり、第 1 のりゅう骨と正反対の位置に空所のため第 2 のりゅう骨を生じたとする (D)。そうすれば出来上った形はネザサ型の芽と同一である。いふかえれば、二側稜型の前出葉に包まれたネザサ型の芽は閉じた形でありオカメザサの芽は開いた形とみることができる。

D. マダケ型の芽の由来

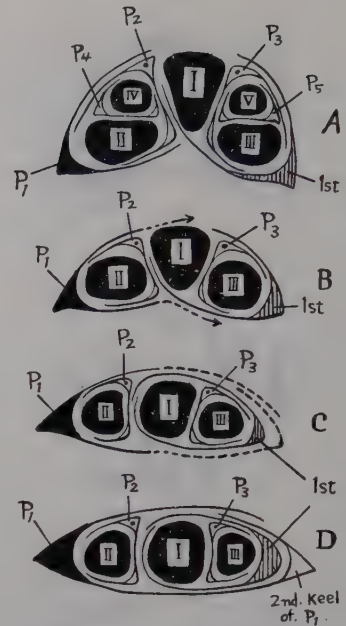


Fig. 5. Diagram showing the transformation from Shibataea Type to Pleioblastus Type. Note the development of the outer prophyll (P_1) becoming to envelope the inner leaf (the 1st foliage leaf) which subtending the first and the third branches. Note also the transformation from the saddle shaped to the eye shaped bud.

オカメザサの芽の解析からマダケ型の芽の型式が導き出される。即ちマダケ型の芽はオカメザサの場合の第 3 枝を消失した形で、単軸分枝と仮軸分枝の両者の型を有するオカメザサ型から仮軸分枝的性質のみになった型がマダケ型と云い得る。

終りにのぞみ、本研究に対し終始御指導を賜った東京大学理学部教授前川文夫博士並びに同研究室の方々に深く御礼を申し上げます。なお本研究は筆者が 1955 年 5 月より 1956 年 4 月迄東京大学理学部植物学教室へ内地研究期間中の成果である。又この期間中数々の御教示、御鞭達頂いた宇都宮大学教授倉田益二郎博士に対し厚く感謝の意を表する。

Résumé

1. Four different types of the bud in the Japanese bamboos were distinguished based on the arrangement of prophyll in the bud, and they were named as follows: *Sasa*, *Pleioblastus*, *Shibataea*, and *Phyllostachys* Type.

2. All of the prophylls found in these types are two-keeled form, except in the *Shibataea* Type.

3. In the interpretation of the prophyll of *Shibataea* Type which seems to be separated double prophylls, the writer is unable to agree with the fusion theory that the prophyll of the two keeled form is formed by the adaxial fusion of the edges of two lateral prophylls. The writer interprete it as follows: If the first leaf develops to envelope the inner one which is the second leaf of the first branch, the edge of the adaxial side is transformed as having a new keel at the opposite of the first keel, and overlap with another edge in the abaxial side (Fig. 5, C). Then we shall obtain the usual two-keeled prophyll derived from the first leaf with one keel.

4. The branching of *Phyllostachys* Type is interpreted as to be derived from the *Shibataea* Type which has both of monopodial and sympodial branching habit.

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コンブ目の形態発生学的研究 II.

スジメの遊走子嚢発生と遊走子形成*

西 林 長 朗**・猪 野 俊 平**

Takeo NISHIBAYASHI** and Shumpei INOH**: Morphogenetical Studies in Laminariales II. The Development of Zoosporangia and the Formation of Zoospores in *Costaria costata* (Turn.) Saunders*

昭和 32 年 3 月 25 日受付

スジメ *Costaria costata* (Turn.) Saunders の生活史については、Angst (1927) および神田 (1936) により詳細に研究されているが、その遊走子嚢発生、ならびに遊走子形成については、いまだに研究されていない。また、近年コンブ目植物の細胞学的研究に関して、Walker が *Macrocystis integrifolia* (1952), *Laminaria digitata* (1954), *L. cloustoni* (unpub.), Magne (1953) が *L. saccharina*, *L. flexicaulis* さらに, Naylor (1956) が *L. digitata*, *L. ochroleuca*, *L. saccharina* の遊走子嚢または、配偶体を用いて観察を行い、その染色体数についても、種々、議論がなされている。しかるに、わが国では、この分野に関する研究はいまだにはほとんど行われていない。

それゆえ、著者らは前報のワカメ、ミツイシコンブの引き続きとして、北海道に産するスジメを材料として、遊走子嚢発生と遊走子形成についての細胞学的な研究を行ったので、その結果をまとめて報告する。

材 料 と 方 法

本研究に使用したスジメ *Costaria costata* (Turn.) Saunders は、1954 年 7 月 29 日から 8 月 2 日の間に北海道大学理学部附属室蘭海藻研究所で採集したものである。採集した材料は、まず醋酸オルセインで遊走子嚢の成熟程度を確かめ、適当な胞子葉を細かく切って、これを著者らの前報のワ

カメおよびミツイシコンブの研究に用いた阿部氏液で 20~25 時間固定した。固定後、パラフィン切片法により、4~5 μ の切片を作り、10%過酸化水素水で漂白した後、ハイデンハイン氏鉄明礬ヘマトキシリンで染色を行ったが、染色体の観察を容易にするため、特に分染には注意を払い薄めに染色して観察を行った。

観 察

1. 遊走子嚢の発生

スジメの葉面には、5 条の縦脈が走っているが、この縦脈は溝状となっており、片面では 3 条凹み、他の面で高まり、他の 2 本は凹凸がそれと反対になっていて、それらが 1 本おきに、ほぼ、平行に通っている。胞子嚢群は、このような葉の下部(葉の全長の基部約 1/6 位の部分)の表裏両面に作られるが、隆起した縦脈の上には決して作られない。

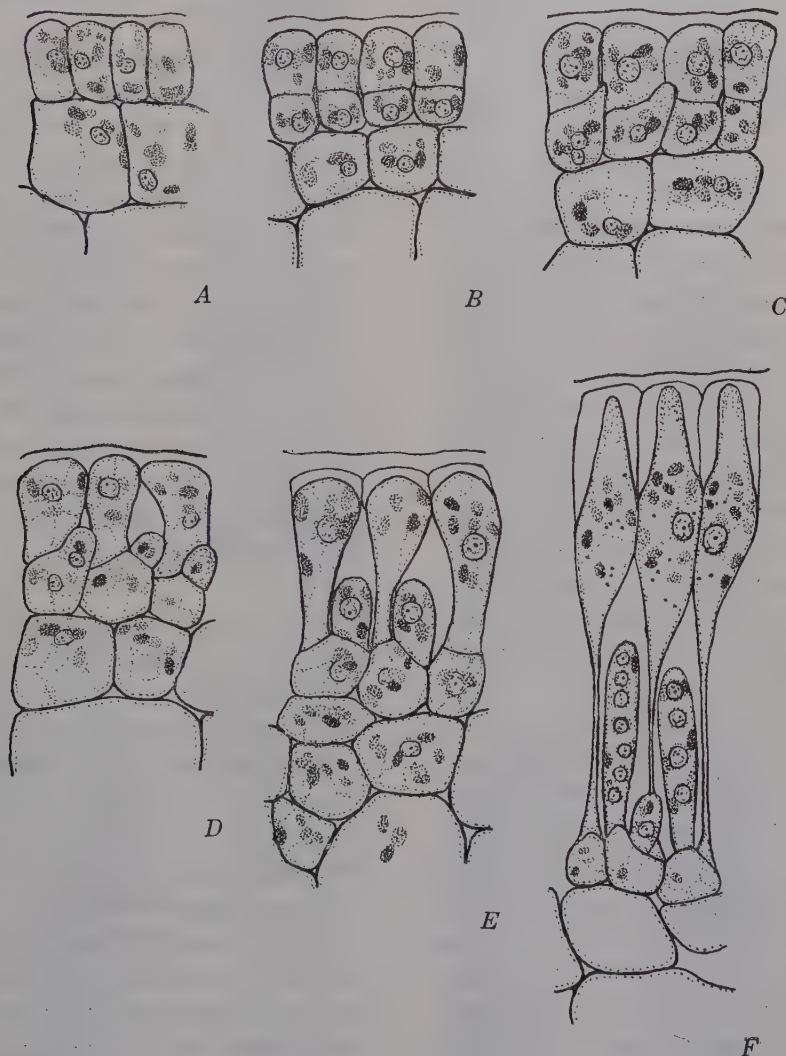
胞子嚢群は側糸と遊走子嚢からできているが、これらの発生は次のようにして行われる。成熟期に達すると、1 核と数箇の色素体を含み、一列に整然と並んでいる表皮細胞は、葉面に平行な膜により、外側の将来、単細胞側糸になる細胞と、内側の底部細胞(basal cell)とに分けられる(Figs. A, B)。その後、間もなく底部細胞はこれらの若い側糸の間に突起を出し始める(Fig. C)。この頃、底部細胞の核は分裂し 2 核となるが、このうちの 1 核は 1 箇の色素体とともに突起の方へ移動

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し、突起の中に完全に入った時、突起は隔膜により底部細胞から切り出され、これが遊走子母細胞となる (Fig. D)。遊走子母細胞も側糸も、その後、ともに成長し、遊走子母細胞内の色素体の数は増加し、その核も大きくなる (Fig. E)。この頃になると、側糸の外膜は粘液により肥厚し始め、

また側糸の頭部には色素体以外に、色素体と同様にヘマトキシリンで染色される小粒が認められるようになる。この小粒は、その後の側糸の成長にともなう、著しく数は増加する。側糸は成長につれてその基部は細くなり、遂には糸状となって、その間で遊走子嚢は成長する。成熟した側糸の頭



Figs. A-F. Development of zoosporangia of *Costaria costata* (Turn.) Saunders. All magnifications ca. $\times 900$.

Fig. A. Section of lamina in sterile portion, showing one layered meristoderm followed by the cells of cortex. Fig. B. Transverse division of the meristoderm to form the basal cell and the future paraphysis. Fig. C. Projection of the basal cell between the young paraphyses. Fig. D. Transverse division of the basal cell to form the zoospore-mother-cell. Fig. E. Growth of the paraphyses. Fig. F. Further stage of development.

部には、中央に一つの核と幾つかの色素体と小粒が認められ、その形は棍棒状を呈しているが、その外膜の肥厚は前に報告したミツイシコンブほど著しくはない (Fig. F)。

2. 遊走子形成

底部細胞から切り出されて間もない遊走子母細胞には、2箇の色素体と静止核が観察される。静止核の中央には、通常、一つの濃く染まる大きな仁が存在し、核内は非常に繊細な網目状構造となっている (Pl. VIII, Fig. 1)。間もなく核分裂の開始とともに、その核は著しく大きくなり、その直径は4~5 μ 位となり、核内の網目状構造は次第に明瞭になってくる (Pl. VIII, Fig. 2)。この頃、約20~23%の割合で核内には二つの仁を含むものが認められるが、これら二つの仁の位置は不規則で、たがいに離れていることもあれば接近していることもある (Pl. VIII, Fig. 3)。その後、染色糸は次第に染色性を増し、ループ (loops) を作って核腔の一隅に集まり、シナプシス期 (synapsis) に入る (Pl. VIII, Fig. 4)。これらの染色糸の幾らかのものは常に仁と密接している。染色糸はその後、核の周辺部に拡がるとともに核腔内部にも伸展し、核腔内に網目を形成してオープン・スピレム期 (open spireme) となる (Pl. VIII, Fig. 5)。オープン・スピレム期以後、染色糸は各所で肥厚しディアキネシス期に入って行くが、仁はこの頃から消失し始め徐々に小さくなり、ディアキネシス期には完全に消失する (Pl. VIII, Fig. 6)。ディアキネシス期には、O, Y, V, II 状の二価染色体が観察され、この頃からディアキネシス末期にかけて、約30の染色体が数えられる (Pl. VIII, Figs. 7, 8)。

中期には、各二価染色体は規則正しく赤道板に並ぶが、その側面観では、これらの染色体はその中央でくびれ、哑鈴状を呈している。この時、染色体以外に紡錘体とその両極には中心体が観察される (Pl. VIII, Figs. 9, 10)。中心体の中央部には、一つまれには二つの中心粒が存在し、そのまわりには均質な中心球が認められ、さらにその外側は濃密な細胞質で取り囲まれているが、*Fucus* ヒバマタ属 (山内, 1909; 猪野, 1935), *Pelvetia* エゾイシゲ属 (猪野, 1935), *Sargassum* ホンダワラ属 (岡部, 1929), *Cystophyllum* ジョロモク属 (猪野, 1944) などのフークス科植物で見られているような顕著な星状体は観察されなかった。核膜は

通常、中期には不明瞭となるが、染色体が赤道板に並び終った後までも、なお残存している場合も観察された (Pl. VIII, Fig. 9)。紡錘体の軸の方向は、遊走子囊の長軸に平行か、または少し傾いている場合が多く、直角な場合はほとんど観察されなかった。それ故、多数の中期像を観察したが、その多くは側面観であり、極面観の立派な中期像を見ることは出来なかった。

後期では、各二価染色体は一価染色体に分れて、規則正しく両極に向って移動する。この時にも中心体は観察された (Pl. VIII, Fig. 11)。終期には、核膜も仁も再び現われ、2娘核は最初がいに接近しているが、後には離れてその間の距離を増す (Pl. VIII, Fig. 12)。2娘核にも二つの仁を持つものが認められた。

第一分裂の後、2娘核の間に隔膜が形成されることなく、引き続いて第二分裂が行われ4核を生じるが、第二分裂における遊走子囊内の二つの核分裂は、ほとんど同時的に行われる (Pl. IX, Figs. 13~15)。これら二つの分裂像はたがいに平行な位置を取ることが多いが、直角な位置を取る場合も観察された。第二分裂の後期も正常に経過し、染色体は規則正しく両極に分れて行く (Pl. IX, Fig. 14)。

その後、引き続き3回の核分裂が行われ、遊走子囊内には32の遊離核が形成される。これらの核分裂はすべて同時的に行われるが、それらの分裂の方向には規則性はない (Pl. IX, Figs. 16~20)。核分裂の回数を重ねるとともに、核および染色体の大きさは段々、小さくなってゆく。第四および第五分裂では核の大きさが小さく、また染色体の観察を容易にするため薄めに染色を行ったので、中心体および紡錘体の存在を確かめることは出来なかった。この間に遊走子囊は成長し、第五分裂終了後はその頂端の膜は著しく肥厚する (Pl. IX, Fig. 20)。遊走子囊内の色素体もこの頃まで数が増加し、第五分裂終了とともに色素体は一箇づつ核の周辺に移動し、その後、細胞質がそのまわりに集まり、薄い膜によってその境が明瞭に仕切られて遊走子が作られる。かくして完熟した遊走子囊は長さ55~75 μ 、幅7~10 μ の大きさとなり、その中には、中央に一つの核と一箇の色素体を有する32の遊走子が作られる (Pl. IX, Fig. 21)。



Plate VIII Formation of zoospores in zoosporangia of *Costaria costata* (Turn.) Saunders. All magnifications ca. $\times 2600$. Fig. 1. Resting stage. Fig. 2. Later stage with reticular structure. Fig. 3. The same stage, showing two nucleoli in the nuclear cavity. Fig. 4. Synapsis stage. Fig. 5. Open spireme stage. Fig. 6. Early diakinesis. Fig. 7. Diakinesis, showing O-, Y-, V-, II-shaped bivalent chromosomes. Fig. 8. Late diakinesis. Fig. 9. Side view of the metaphase, showing the nuclear membrane beginning to disappear. Fig. 10. The same stage, showing the centrosomes at the both poles of the spindle. Fig. 11. Anaphase. Fig. 12. 2 daughter nuclei.

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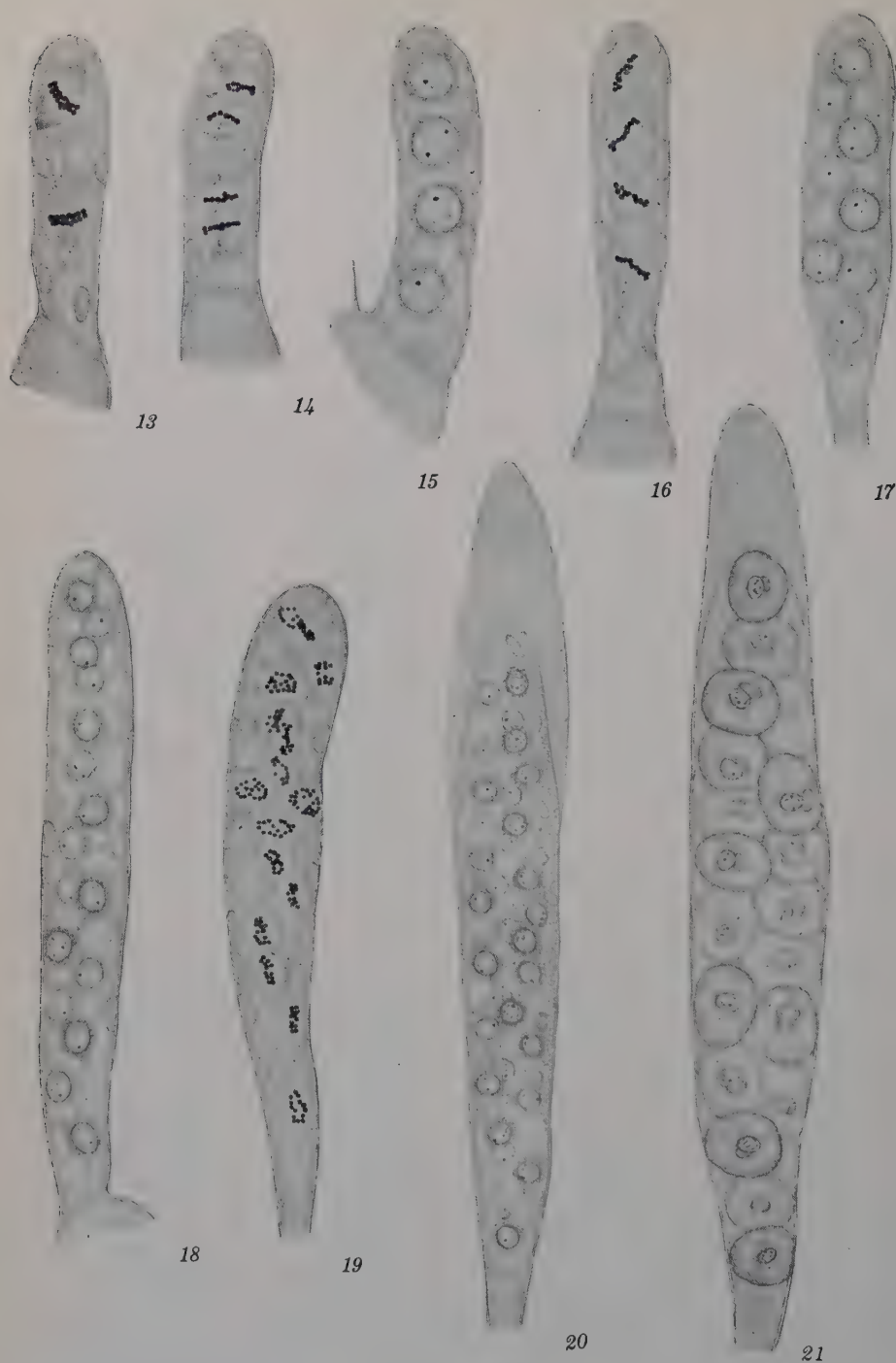


Plate IX Formation of zoospores in zoosporangia of *Costaria costata* (Turn.) Saunders. All magnifications ca. $\times 2200$. Fig. 13. Metaphase of the second meiotic division. Fig. 14. Anaphase of the same division. Fig. 15. 4 nucleate stage. Fig. 16. Metaphase of the third nuclear division. Fig. 17. 8 nucleate stage. Fig. 18. 16 nucleate stage. Fig. 19. Metaphase of the fifth rangium. Fig. 20. 32 nucleate stage. Fig. 21. Zoospores formed completely in a zoosporangium.

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考 察

スジメの遊走子嚢の発生様式は、詳細な点を除き、他のコンブ目植物についての報告と同じであり、遊走子嚢も側糸も葉の表皮細胞から発生する。スジメの遊走子嚢発生を、前に著者らが報告したミツイシコンブ (1956) と比べると、ミツイシコンブでは底部細胞からの、将来、遊走子母細胞となるべき突起の伸出は側糸が幾分伸長してから行われたが、スジメでは表皮細胞が底部細胞を切り出して後、直ちに突起の伸出が行われる。即ちスジメでは、突起の伸出はミツイシコンブよりも早い時期に行われている。成熟した側糸の頭部の形は、ミツイシコンブは非常に細長い棍棒状を呈しているが、スジメではそれほど細長くはない。この相異はその外膜が粘液質により肥厚するため、粘液質が比較的多いミツイシコンブはその外膜の肥厚が著しいので、非常に細長くなったものと思われる。

第一分裂のデオキネシス期には、種々な形をした二価染色体が観察されたので、本植物の遊走子嚢における最初二回の核分裂は減数分裂である。第一分裂中期において、核膜が消失しないで残存しているものが観察されたが、このことはすでに議論されてきたように、紡錘体が核内起源のものであることを裏付ける。

コンブ目植物の染色体数については、古くは *Chorda filum* で $n=20$ (Kylin, 1918), *Egregia Menziesii* は $n=8$ (Myers, 1928), *Pterygophora californica* は $n=13$ (McKay, 1933), *Eisenia arborea* は $n=15$ (Hollenberg, 1939), *Laminaria japonica* は $n=22$ (阿部, 1939) と報告され、最近では、その遊走子嚢および配偶体のフォイルゲン反応、または醋酸カーミン染色によるおしつぶし法により、*Macrocystis integrifolia* は $2n=32$ (Walker, 1952), *L. cloustoni* は $2n=22$ (Walker, unpub.), *L. flexicaulis* は $n=13$ (Magne, 1953), *L. saccharina* は $n=13$ (Magne, 1953), *L. digitata* は $n=8$ (Walker, 1954), *L. digitata*, *L. ochroleuca*, *L. saccharina* の三種はともに

$n=27\sim 31$ (Naylor, 1956) と報告され、また著者らは *Undaria pinnatifida* は $n=22$ (1954), *L. angustata* も $n=22$ (1956) と報告したが、本種では $n\approx 30$ の染色体が認められた。このように、コンブ目植物の染色体数はその種により、また同一種でも非常に異なった報告がなされており、これに関する詳細な知識は今後の研究によらなければ得ることが出来ない。また、本種の染色体は他のコンブ目のものと同様、非常に小さいので観察し難く、そのため本種の染色体数に関しても、今後、配偶体における染色体の観察などを行って正確に決定したい。

一つの遊走子嚢内に形成される遊走子の数についても、*Chorda filum* の 16 (Kylin, 1918), *Alaria esculenta* (Sauvageau, 1918), *L. saccharina* (Schreiber, 1930), *Pelagophycus porra* (Herbst and Johnstone, 1937), *Eisenia arborea* (Clare and Herbst, 1938), *L. japonica* (阿部, 1939), *Undaria pinnatifida* (猪野・西林, 1954) および *L. angustata* (西林・猪野, 1956) の 32, *Pterygophora californica* (McKay, 1933) および *Eisenia arborea* (Hollenberg, 1939) の 32 時々 64, *Saccorhiza bulbosa* (Sauvageau, 1918) の 128 と多くの報告がなされているが、本種では常に 32 の遊走子が形成された。以上の結果から、いくつかの例外を除きコンブ目植物の多くは 32 の遊走子を形成するのではないと思われる。

L. japonica (阿部, 1939), *Undaria pinnatifida* (猪野・西林, 1954) および *L. angustata* (西林・猪野, 1956) では、紡錘体の一極または両極に中心体状の小粒の存在が報告されているが、本種では紡錘体の両極に、一つまたは二つの中心粒とそのまわりには中心球が観察されたので、本種では明らかに紡錘体の両極に中心体が存在する。

本研究を行うに当たり、材料の採集、実験に多くの便宜をいただいた、北海道大理理学部附属室蘭海藻研究所所長山田幸男博士、ならびに中村義輝博士に厚く御礼申し上げます。

Summary

1. Both the zoosporangia and the paraphyses originate from the superficial cells of the sporophylls.

2. The first and the second nuclear divisions in the zoosporangium are meiosis, and then three successive mitoses take place to form 32 free nuclei. Consequently 32 haploid zoospores are produced in a zoosporangium.

3. The haploid number of chromosomes in *Costaria costata* is about 30.

4. The centrosomes are visible at both poles of the spindle.

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塩 原 温 泉 の ケ イ 藻

小 林 艶 子*

Tsuyako KO-BAYASHI*: Diatom Vegetation of Shiobara Spas.

昭和 32 年 5 月 13 日受付

塩原温泉は古くより有名な温泉で、藻類の研究も H. Molisch 博士 (1926) 及び江本義教・広瀬弘幸両博士 (1942) によって行われ日本では比較的良好に研究が行われた温泉群の一つであるが、ケイ藻類に関しては全然記録が無く江本・広瀬両博士が「珪藻類は甚だ其種類に於いて尙た又量に於いても多いのであるが、他日を期して報告する考えである」と記されているだけであるので、著者は 1954 年 3 月 31 日より 4 月 3 日に到る迄元湯を

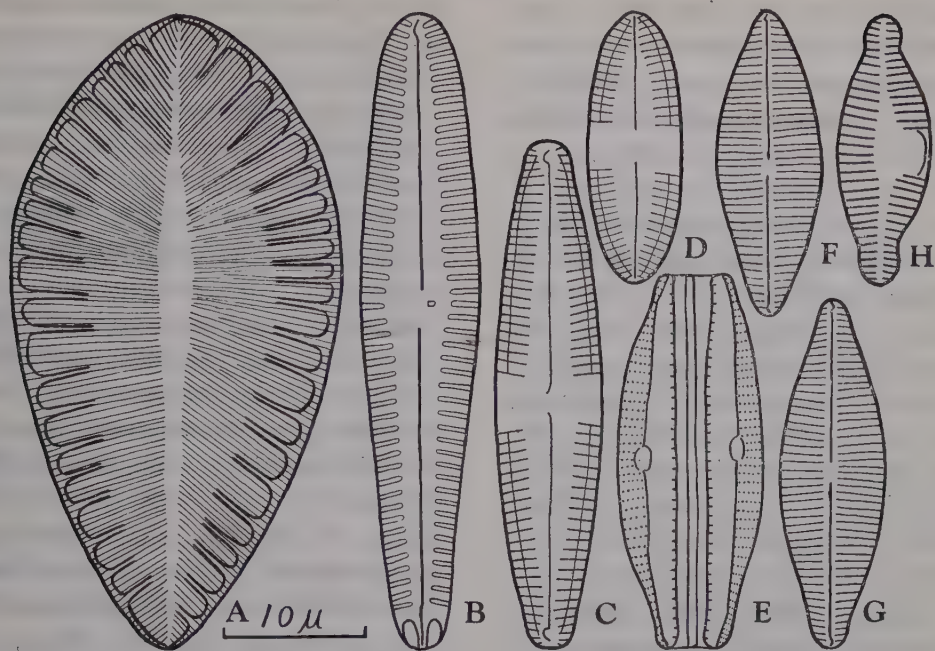
除く本温泉群の採集を行われた横浜市立大学福島博助教授の材料を研究させて載いたのでその結果を報告する。

貴重な資料を提供し、研究の指導と校閲をして下さった福島博先生に厚く感謝致します。

調 査 源 泉 の 概 況

1. 大網温泉 川岸に野天風呂があるが入浴者多く温泉藻の調査に不向なので割あいした。

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A: *Surirella ovalis*B: *Gomphonema Clevei*C: *Caloneis Clevei*D: *Caloneis bacillum*E: *Amphora Normanni*F: *Navicula halophila*G: *N. h. f. subcapitata*H: *Fragilaria capitellata*

2. 福渡戸温泉 (調査地点 I, II) 箒川岸に冷の湯, 泡の湯, 子持の湯等いくつかの共同浴場があり, 大低は浴槽の底から湧出するもので温泉藻の調査に適しないが箒川の右岸の石の湯附近では岩石の裂目の4か所より湧出していたので調査した。調査地点 A, B, C, D は夫々水温は 26.8°, 34.0°, 36.8°C, 不明で, pH は 7.6, 6.1, 6.2 で Cl⁻ は 733, 812, 839, 845 mg/l でいずれも相当塩分を含んでいた。これらの全地点では青緑色又は緑褐色の藻類が発達していたがケイ藻の見られたのは A 地点 (Sample No. 5), B 地点で前者では 11 種 (変種, 品種を含む。以下同じ) で主要種は *Navicula halophyla* (CC), *Cymbella* sp. (C), *Gomphonema parvulum* (+) で *Navicula halophyla*-*Cymbella* sp. 群落であった。後者では 1 種見られただけで個体数は大変稀であった。福渡戸温泉の旅館は約 2 km 離れた塩釜温泉から引湯しているのでこの代表的なものとして和泉館の引湯管の漏水を A 及び B の 2 地点調査した。水温は 53.9, 54, 54, 51.2°C であったが両地点共ケイ藻の個体数は少かった。

3. 塩釜温泉 箒川の対岸の塩の湯に通じる橋の下の温泉 (塩原館源泉) を調査したがケイ藻は見られなかった。時間の都合で塩釜温泉ではこの源泉を調査しただけである。

4. 畑下温泉 (調査地点 IV A~C) 畑下温泉にもいくつかの源泉があるが温泉藻の採集に適当なのは次に記す源泉だけである。清琴楼の石垣風呂と箒川との間にあるもので, セメントで囲った 2×1.4×0.4 m 位のもので底から自然湧出していた。夏は浴用にされることがあるそうであるが, 他の時期はバケツ又はポンプで汲上げて洗濯等に使用されている。調査当時は藍藻が一面に生えていた [気温 12.0°C, 水温 33.0°~34.4°C (7 時) Cl⁻ 566 mg/l]。ケイ藻は 7 種産し *Navicula cryptocephala* 群落であった。

5. 門前温泉 (調査地点 V A~C) 門前温泉にも沢山な源泉がある様であったが, 温泉藻の採集に好適なのは次の一か所だけであった。箒川の右岸 (翁の湯の対岸) に昭和 28 年頃出来た野天風呂があるが水温が低い為殆んど使用されず, 浴用として夏利用されることもあるという程度で,

平素は洗濯に利用されているようである。この野天風呂は 2.5×1.4 m 位のものでセメント壁に囲まれており水深は約 40 cm あった。ケイ藻は 27 種を数え、*Nitzschia palea* 群落であった。(水温 $38.0 \sim 38.8^\circ\text{C}$, 気温 16.8°C , pH 6.6)

6. 古町温泉 (調査地点 VI A・B, VII)

古町温泉で温泉藻の採集に适当と想われる、花月の湯引湯管漏水、柏木館内未使用の自噴泉、柏木館隣の自噴泉(下塩原 113 番地)の3か所を調査したがケイ藻の見られたのは後の2か所だけであった。柏木館内自噴泉の湯の出ている場所は9種見られ *Nitzschia palea* 群落で、湯のかゝる板に発生した青藍色の藻被では8種数えられ *Nitzschia palea*-*Nitz. amphibia* 群落であった。水温 20.2°C , pH 7.4, Cl^- 129 mg/l. 柏木館隣の自噴泉ではケイ藻が少く1種見られたただけであった(水温 27.2°C , pH 7.2, Cl^- 49 mg/l)。

7. 新湯温泉 (調査地点 VIII) 調査当時は中の湯だけ湧出していた。新湯は強酸性の温泉で今回の調査では正確な pH は測定出来なかったが江本・広瀬博士によると中の湯が pH 2.6, 寺の湯が pH 2.0 となっている。*Pinnularia Braunii* (var. *amphicephala* を含む) 1 種が夥しく繁殖し褐色の藻被を形成していた(水温 23.8°C , 気温 18°C (15 時), pH 3.2 以下)。

8. 須巻温泉 (調査地点 IX A・B, X)

旅館で浴用に供している源泉は常時は蓋がしてあって温泉藻の採集には不适当であるが、この源泉より約 30 m 旅館よりの地表に温泉水が滲出して緑色の藻被が見られた。ここには9種ケイ藻が数えられ *Navicula cryptocephala* 群落であった(水温 33.2°C , 気温 14.2°C (9 時), pH 6.8)。今一つの源泉は径約 40 cm のパイプの底より湧出していたが湧出量は極めて少量で水酸化鉄の沈でんが多量見られ *Navicula cryptocephala* 群落であった(水温 31.5°C)。

9. 柚が沢温泉 (調査地点 XI A・B, XII)

万人風呂裏の溪流傍より湧出している湯を引いて浴用に供していたが、この源泉には水酸化鉄の沈でんが夥しくケイ藻が見られなかった。万人風呂横に熱い湯とぬるい湯が湧出していたがケイ藻の種類と量は多くなく、8 種数えられただけで、いって群落名をつけると *Cymbella aspera*-*Gomphonema parvulum*-*Navicula cryptocephala*

群落(水温 24.6°C)と *Gomphonema gracile* 群落(水温 24.0°C , pH 7.5)であった。

10. 塩の湯温泉 明賀屋旅館の源泉を調査したが、川辺の岩盤から湧出しているのを直ちに浴槽として利用している野天風呂で、これは温泉藻の採用には不适当なので採集しなかった。今一つは対岸より引湯しているがこれらの引湯管の漏水に発生している藻被を調査したがケイ藻は見られなかった。

塩原温泉群で今回見出したケイ藻は後記の目録に示すように 55 種でこの中日本新産種は *Caloneis Clevei*, *Cyclotella Kützingiana* var. *radiosa*, *Denticula thermalis*, *Fragilaria capitellata*, *Navicula halophila* f. *subcapitata*, *Nitzschia microcephala* の6種で、日本温泉新産種は *Achnanthes lanceolata* var. *elliptica*, *Amphiprora alata*, *Amphora Normanni*, *Cyclotella Kützingiana*, *Diploneis ovalis*, *Gomphonema parvulum* var. *subellipticum*, *Navicula contenta*, *N. halophila*, *Nitzschia vitrea*, *Stephanodiscus astraerae*, *S. a.* var. *minutula* の11種である。

主要ケイ藻について

1. *Cymbella aspera* (Ehr.) Cleve 本種は広く分布し、普通に見出される種で塩分に対して不定性 (Kolbe 1927, Foged 1948, 1954), 好アルカリ性で流れに対して不定性 (Foged 1948, 1954) とされているケイ藻で日本に於いても十数か所記録されている。今回 柚が沢温泉の一源泉 (WT, 24°C) で優占種の一つであった。

2. *Gomphonema gracile* Ehr. 各種の水域に広く分布しており、特に熱帯地方に多いと云われているが我が国でも数か所見出されている。今回の調査では柚が沢温泉の1源泉 (WT 24°C , pH 7.5) で優占種であった。本種を Foged (1954) は好止水性、不定性 (塩分に関して) としているが Hustedt (1938) は貧鹹性とし pH 5.5 より 8.9 の間に多産するとしている。日本温泉新産種である。

3. *Gomphonema parvulum* (Kütz.) Grun.

各種の水域に広く分布し、しばしば夥しく産する種であるが、Hustedt (1930) は特に止水に多いとしているが Foged (1948, 1954) は好流水性としており、兵庫県の円山川水系でも時々優占種

となるそうで (福島先生の未発表資料による), また筆者等の調査で千曲川水系にも広く分布し, しばしば優占種になることが判った (長野県 1957)。塩分に対して好鹹性 (Kolbe 1927), 不定性 (Boye-Petersen 1943, Foged 1954), 不定性で好鹹性 (Hustedt 1938, Foged 1948) 等と記されており, また狭温性でジャバ, スマトラの温泉には産しない (Hustedt 1938) そうであるが, 日本では日光湯元温泉, 群馬県八塩鉱泉, 岐阜県平湯温泉, 槍見温泉, 富山県城端ラジウム鉱泉, 大阪府錦旗鉱泉, 和歌山県鮎川温泉等の諸鉱泉で知られ, 最高温度は平湯温泉の 32°C である。日本に於いては上記の外数か所でも記録されている。今回は袖が沢温泉の一源泉 (WT 24.6°C) で優占種の一つであった。

4. *Navicula cryptocephala* Kütz. 淡水域に広く分布し, 時には汽水域にも広く分布する種で, 塩分に対し, 好鹹性 (根来 1942), 好塩性? (Kolbe 1927, Schulz 1928, Budde 1930, Springer 1930) 強い広鹹性 (Budde 1932), 広鹹性? (Legler und Krasske 1940), 不定性で広鹹性 (Foged 1948), 不定性 (Hustedt 1938, Boye-Petersen 1943, Foged 1954) といいろいろ記されている。また好アルカリ性で流れに対して不定性 (Foged 1948, 1954) とされている。日本に於いて 30 余か所の地点で記録されており特に食塩を含む鉱泉で多く見出されているが淀川水系 (河村 1956) や千曲川水系 (長野県 1957) でもしばしば優占種となることが記録されているので広塩性とすべきであろう。今回は畑下温泉の一源泉 (WT $33-34.4^{\circ}\text{C}$, Cl^- 566 mg/l) で優占種で, 袖沢温泉の一源泉 (WT 26°C) で優先種の一つであった。

5. *Navicula halophila* (Grun.) Cleve

好鹹性より中鹹性 (Hustedt 1938), 中鹹性 (Hustedt 1930, Boye-Petersen 1943, Foged 1948, 1954), 好止水性 (Foged 1948) とされている種で, 日本では長野県和村のケイ藻土より記録されているだけのようであるが, 今回は福渡戸温泉石の湯の一源泉 (WT 26.8°C , pH 7.6, Cl^- 733 mg/l) で優占種の一つであった。日本温泉新産種である。

6. *Nitzschia amphibia* Grun. 広く分布ししばしば夥しく産する種で塩分に対しては貧鹹性

(Kolbe 1927, Schulz 1928, Hustedt 1938), 不定性 (Kolbe 1927, Boye-Petersen 1943, Foged 1948, 1954) とされ, 真アルカリ性で流れに対して不定性である (Foged 1948, 1954) とされている種で日本に於いては数か所の陸水と十数か所のケイ藻土から記録されており, 今回は古町温泉の一調査地点で優占種の一つであった。

7. *Nitzschia palea* (Kütz.) W. Smith

淡水域に広く分布し, しばしば夥しく出現する最も普通なケイ藻の一種で塩分に対して不定性 (Kolbe 1927, Hustedt 1938, Foged 1948, 1954), 流れや pH に対しても不定性であるとされている (Foged 1948, 1954)。銅に対する抵抗力も強いようで (Schwarbe 1939), 日本の銅鉱排水の群落の主要構成種の一種である (福島先生未発表資料による)。日本に於いては鉱泉, その他の水域で夫々十数か所で記録されているが, 今回は門前 (WT $38-38.8^{\circ}\text{C}$ pH 6.6) 及び古町温泉 (WT 20.2°C , pH 7.4, Cl^- 129 mg/l) の一源泉で優占種で, 古町温泉の一調査地点で優占種の一つであった。

8. *Pinnularia Braunii* (Grun.) Cleve

基本種と var. *amphicephala* (A. Mayer) Hustedt との移行型も見られるので, この論文ではこの変種の区別をしなかった。陸水域に広く分布する種で日本でも数か所の淡水域でも記録されているが個体数は多くはない。無機強酸性水域には極めて広く分布し夥しく産し, しばしば純群落を形成する。藍藻の *Cyanidium caldarium* と共に無機強酸水域の代表的藻類である。また食塩を多量に含有する鉱泉でもしばしば見出される。今回は新湯温泉中の湯 (WT 23.8°C , pH < 3.2) で優占種であった。

ケイ藻目録

(種名の次のローマ数字は採集地点, その次の () 内の +, C, CC の記号は頻度で夫々普通, 多い, 夥しいを示す)

1. *Achnanthes exigua* Grun. VIA, VIB, VA, VB, VC.
2. — *lanceolata* Bréb. VB, VC.
3. — — var. *elliptica* Cleve VC. 日本温泉新産種.
4. *Amphiprora alata* Kütz. VB. 日本温泉新産種.

5. *Amphora Normmanni* Rabh. IXA.
6. *Caloneis bacillum* (Grun.) Mereschkowsky IXA.
7. — *Clevei* (Lagst.) Cleve IIIB, IXA. 日本新産種.
8. *Cocconeis placentula* Ehr. VC.
9. — — var. *euglypta* (Ehr.) Cleve VC.
10. — — var. *intermedia* (Hér. et Perag.) Cleve? IIIB.
11. *Cyclotella Kütziana* Thwaites VIA, VC. 日本温泉新産種.
12. — — var. *radiosa* Fricke IIIB, VC. 日本新産種.
13. *Cymbella* sp. I(c), VC.
14. — *aspera* (Ehr.) Cleve I, XIB(+), XIII.
15. — *sinuata* Gregory VC.
16. — *tumida* (Brébisson) Van Heurck I, IIIB.
17. — *turgidula* Grun. VC.
18. — *ventricosa* Kütz. VC.
19. *Denticula thermalis* Kütz. I, II, VII. 日本新産種.
20. *Diploneis ovalis* (Hblse) Cleve I. 日本温泉新産種.
21. *Epithemia sorex* VIB, VB.
22. — *turgida* (Ehr.) Kütz. var. *Westermanii* Grun.? IXA.
23. *Fragilaria capitellata* (Grun.) Boye P. VC. 日本新産種.
24. — *Vaucheriae* (Kütz.) Boye P. IIIB.
25. *Gomphonema Clevei* Fricke IIIB.
26. — *gracile* Ehr. XII(+).
27. — *micropus* (Kütz.) Cleve IXA.
28. — *olivaceum* (Lyngbye) Kütz. VC.
29. — *parvulum* (Kütz.) Grun. I(+), IVC, IXA?, XIB(+).
30. — — var. *subelliptica* Cleve VC, IXA. 日本温泉新産種.
31. — *tetrastigmata* Horikawa et Okuno VC.
32. *Mastogloia Smithii* Thwaites var. *lacustris* Grun. I.
33. *Melosira varians* C. A. Agardh IIIB, VIB, VA, VC.
34. *Navicula contenta* Grun. XII. 日本温泉新産種.
35. — *cryptocephala* Kütz. IIIB, VIA(+), VIB, VA(r), IVA, IVB, IV(C), IXA(C), IXB(C), X(+), XIB(+).
36. — — var. *exilis* (Kütz.) Grun. VIA.
37. — — var. *veneta* (Kütz.) Grun. VIA(+), VIB, IVC.
38. — *cryptocephaloides* IIIB.
39. — *halophila* (Grun.) Cleve I(cc). 日本温泉新産種.
40. — — f. *subcapitata* Oesterup I(+). 日本新産種.
41. — *simplex* Krasske I.
42. *Nitzschia amphibia* Grun. IIIB, VIA(+), VIB(cc), VC, IVC, XII.
43. — *linearis* I.
44. — *microcephala* Grun. IIIB. 日本新産種.
45. — *palea* (Kütz.) W. Smith. VIA(c), VIB(cc), VA(c), VC.
46. — *vitrea* Norman IIIB. 日本温泉新産種.
47. *Pinnularia Braunii* (Grun.) Cleve VIII(cc). IVC.
48. *Rhoicosphenia curvata* (Kütz.) Grun. IIIB. VIB, VA, VB.
49. *Rhopalodia gibba* (Ehr.) O. Müll. IXA.
50. — *gibberula* (Ehr.) O. Müll. I, IIIA, IIIB, VIA, VC, XIA.
51. *Stephanodiscus astraea* (Ehr.) Grun. VA, VB, VC. 日本温泉新産種.
52. — — var. *minutula* (Kütz.) Grun. 日本温泉新産種.
53. *Surirella ovalis* Bréb. IIIB.
54. *Synedra ulna* (Kütz.) Ehr. IVC(+).
55. — — var. *oxyrhynchus* (Kütz.) van Heurck IIIB, VA, VB, VC.

Summary

In 20 among 42 samples of diatoms at Fukuwata, Shiogama, Hataori, Monzen, Furumachi, Arayu, Sumaki, Sodegasawa and Shionoyu spas in Shiobara district of Tochigi Pref., the writer found 55 taxa. Those data are as follows:

Place	Station	pH	Water Temp. °C	Air Temp. °C	Cl ⁻ mg/l	Diatom Community
Fukuwata spa (Ishino Yu)	I	7.6	26.8	18.0	733	<i>Navicula halophila</i> - <i>Cymbella</i> sp. Association
"	II	6.1	36.8	—	839	—
Fukuwata spa (Izumikan)	III A	6.8	58.9	—	373	—
"	III B	—	51.2	—	—	—
Hataori spa (Seikin Rô)	IV A	—	34.3	—	—	—
"	IV B	—	33.0	—	—	—
"	IV C	6.6	33.0	—	566	<i>Navicula cryptocephala</i> Assoc.
Monzen spa (Noten Buro)	V A	6.6	38.8	16.8	695	<i>Nitzschia palea</i> Assoc.
"	V B	—	38.0	—	—	—
"	V C	—	38.0	—	—	—
Furumachi spa (Kashiwagi Kan)	VI A	7.4	20.2	—	130	<i>Nitzschia palea</i> Assoc.
"	VI B	—	—	—	—	<i>Nitz. palea</i> - <i>Nitz. amphibia</i> Assoc.
Furumachi spa	VII	7.2	27.2	—	49	—
Arayu spa (Nakano Yu)	VIII	3.2	23.8	—	38	<i>Pinnularia Braunii</i> Assoc.
Sumaki spa	IX A	6.8	33.2	—	—	<i>Navicula cryptocephala</i> Assoc.
"	IX B	6.8	33.2	—	—	"
"	X	—	31.5	—	—	"
Sodega Sawa spa	XI A	—	24.9	—	—	—
"	XI B	—	24.6	—	25	<i>Cymbella aspera</i> - <i>Gomphonema parvulum</i> - <i>Navicula cryptocephala</i> Assoc.
"	XII	7.5	24.0	—	65	<i>Gomphonema gracile</i> Assoc.

New additional species to Japan: *Caloneis Clevei*, *Cyclotella Kütziana* var. *radiosa*, *Denticula thermalis*, *Fragilaria capitellata*, *Navicula halophila* f. *subcapitata*, *Nitzschia microcephala*.

New additional species to Japanese thermal flora: *Achnanthes lanceolata* var. *elliptica*, *Amphiprora alata*, *Amphora Normanni*, *Cyclotella Kütziana*, *Diploneis ovalis*, *Gomphonema parvulum* var. *subelliptica*, *Navicula contenta*. *N. halophila*, *Nitzschia vitrea*, *Stephanodiscus astraea*, *S. a.* var. *minutula*

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エノキタケの遺伝学 IV

一系統 NL-55 菌にみられる“中間極性”*

武 丸 恒 雄**

Tsuneo TAKEMARU**: Genetics of *Collybia velutipes*, IV.

“Interpolarity” Occurring in the Strain NL-55.*

昭和 32 年 5 月 7 日受付

エノキタケ *Collybia velutipes* の交配型については、Kniep (1920) が本菌のヘテロタリズムを証明したのに始まり、Vandendries (1923) と Zattler (1924) が random spores による間接的な方法で、更に Funke (1924) が tetrad spores による直接的な分析を行って、何れも本菌が四極性であることを明快に示した。その後多くの研究者達によってこれらの結果が確認された (Newton 1926; Heldmaier 1929; Brodie 1936; Oddoux 1953; Takemaru 1954)。最近 Aschan (1954) は、本菌にいわゆる illegitimate dikaryotization が規則的に起こる場合を発見したが、この二核化は交配された 2 菌糸体間の境界線にのみ限定され、何れの菌糸体の側にも二核菌糸の形成は行われなかった。更にこれらの illegitimate の交配によって生じた二核菌糸体からは、胞子を形成するような満足の子実体は発生しなかった。筆者がストックしている本菌の一系統についても illegitimate dikaryotization の現象がみられたが、二三の重要な点で上記 Aschan の報告と異なっている。その結果二極性と四極性の正に“中間をゆく”型が得られたので、これを“中間極性 interpolarity”と名付けて報告する。

材料及び方法

本実験に用いた材料は全て、エノキタケの一系統 NL-55 菌から由来するものである。本系統の

二核菌糸体を、1956 年 2 月 7 日に馬鈴薯蔗糖寒天の斜面上に植え、10 日間 25°C の定温器で暗培養した後、室内に移して明培養を続けた。この試験管培養から、同年 4 月 7 日に成熟した子実体 55P がえられた。この子実体の spore deposit から、稀釈平板法によって、17 単胞子を分離した。これらを更に別の寒天平板上に移植し、その後の生育を顕微鏡によって入念に検査して、単胞子分離であることを確認した。以上のようにして得られた単胞子菌糸体 No. 1~17 を、2 系統づつあらゆる組合せで交配し、12 日間 25°C で培養した後、クランプ形成の有無を検鏡した。検鏡は、まず両菌糸体間の境界線について行い、次にその両側の菌糸体について調査した。尚、検鏡を容易且つ正確にするため、0.025% または 0.05% メチレンブルー水溶液で以て菌糸の隔膜を染色する方法を行った。

子実体形成の実験については、Aschan (1954) は一本の二核菌糸から出発する方法を採用している。これは本菌では時として、一核菌糸体が単独で単相子実体を形成することが知られているので (Zattler 1924; Brodie 1936; Takemaru 1954)、このために生ずる結果の混乱を懸念したためと思われる。しかし筆者の場合には、予備実験によって、単相子実体形成可能な単胞子菌糸体が判明していたため、一本の二核菌糸を取出す手数を省き、二核化がおこった組合せの全部について単に

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side by side 培養を行うことによって、子実体形成の有無並びに発生をの程度を調べた。単相子実体形成可能の単胞子菌糸体が関係する組合せから発生した子実体については、それが一核性のものか二核性のものであるかをその都度調査した。子実体形成のための培養方法は上述の通りである。尚、培養条件は各組合せについて出来るだけ齊一になるよう心掛けた。早いものでは、交配後1月で子実体の形成をみたが、遅れる組合せもあることを考慮して、未形成のものについては、交配後3ヶ月まで培養を続けた。

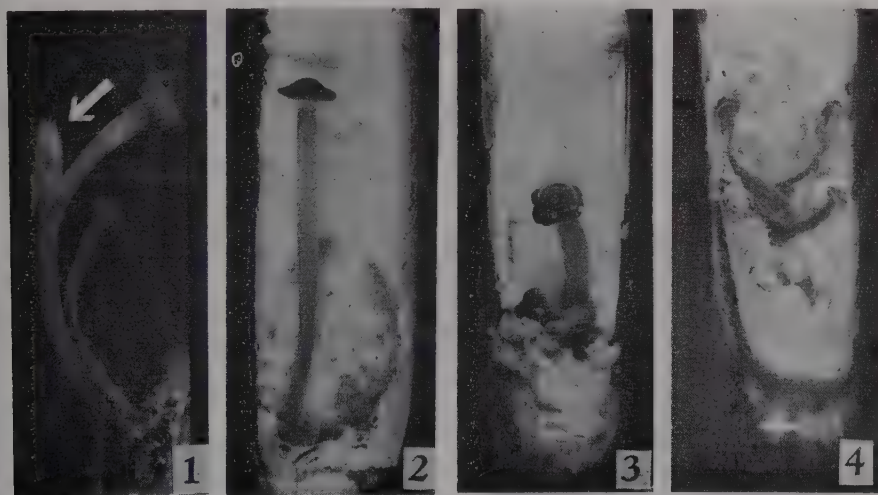
実験結果

i) 交配反応：子実体 55 P から分離された上記 17 単胞子菌糸体を 2 系統づつあらゆる組合せで交配して、クランプ形成反応を調べた。この実験は、単胞子の分離直後、およびそれより半年後の 2 回にわたって行った。この結果は Table 1a にまとめて示されている。表中小さい記号を 2 個並べてあるのは、2 回の実験で異なる結果が得られた場合を表わし、左側が第 1 回、右側が第 2 回

の実験結果をそれぞれ示している。2 回とも同一の結果を得た場合は、1 箇の大きな記号で表わしてある。またクランプ形成が、交配された 2 菌糸体間の境界線においてのみ見られる場合（限定二核化）を記号 “(+)”，境界線は勿論のことその両側 bilateral 或は片側 unilateral にも見られる場合（完全二核化）を記号 “+” を以て示した。何れの部位にもクランプの形成をみなかった組合せは、記号 “-” で表わされている。

一般に、単胞子分離直後の若々しい菌糸体の間では極めて活潑なクランプ形成反応を示すけれども、培養が古くなるにつれて、この反応が漸次弱くなることが知られている。例えば、Aschan (1954) が用いたエノキタケの A-系統における分離直後の交配実験と、それより約 4 年後の同一実験の結果を比較してみても、かなりクランプ形成能が低下していることが肯ける。筆者の行った実験の範囲でも、このような傾向をもった組合せは勿論みられたけれども、半年後の実験の方で却って強い反応を示した組合せさえあった。

illegitimate の交配では、生じたクランプの腕



Figs. 1-4. The fruit-bodies of *Collybia velutipes* growing on potato-sucrose agar slants in test tubes (Natural size). Fig. 1. Mature fruit-bodies obtained from the illegitimate pairing $7(A^2B^1) \times 17(A^2B^2)$. An arrow sign indicates the spore deposit. Fig. 2. Typical fruit-body derived from the legitimate mating $13(A^1B^1) \times 17(A^2B^2)$. Fig. 3. Haploid fruit-body developing from 5 mycelium of illegitimate $4(A^2B^2) \times 5(A^2B^1)$ combination. The appearance is rather harmonious, but the spore formation is very poor. Fig. 4. Haploid fruit-bodies formed by the monosporous mycelium 5 alone.

Table 1a. "Interpolar" mating pattern of the strain *NL-55* (fruit-body *55P*) obtained from two matings, one in April 1956 immediately after isolation of the single basidiospores and one in October 1956. Pairings which showed the same clamp-forming reaction all two times are marked with one large sign. The combinations in which different results were obtained between two matings, are indicated by two successive small signs, the former of which shows the result in April, the latter in October, respectively. "+" denotes complete dikaryotization on either side of the contact zone; and "(+)", limited dikaryotization found only in the contact zone between two mated mycelia. In the pairings denoted by "-", no clamp-connection has been observed.

Table 1b. Fruit-body formation from all pairings in which dikaryotization has occurred, and from 17 monosporous mycelia themselves. "F" indicates perfectly developed fruit-bodies bearing abundant basidiospores (Figs. 1-2); "f", half-developed fruit-bodies with stipes and undeveloped pilei, no spore being formed (Fig. 4); and "r", fruit-body rudiments. Such fruit-body as shown in Fig. 3 affects "F", but produces only small number of spores. So it is also classified into "f". Fruit-bodies marked with an asterisk * are haploid. Pairings denoted by "-" have not yet given rise to any fruit-bodies or rudiments.

	1	6	13	4	8	14	15	17	2	9	11	12	3	5	7	10	16	
1	-	-	-	+	+	+	+	+	~(+)	-	(+)	-	-	-	-	-	-	A ¹ B ¹
6	-	-	-	+	+	+	+	+	~(+)	-	(+)	-	-	-	-	-	-	
13	-	-	-	+	+	~(+)	+	+	-	-	~(+)	-	-	-	-	-	-	
4	+	+	+	-	-	-	-	-	-	-	-	-	+	(+)	(+)	+	+	A ² B ²
8	+	+	+	-	-	-	-	-	-	-	-	-	+	+	+	(+)	+	
14	+	+	~(+)	-	-	-	-	-	-	-	-	-	~(+)	+	+	~(+)	(+)	
15	+	+	+	-	-	-	-	-	-	-	-	-	~(+)	+	+	~(+)	+	
17	+	+	+	-	-	-	-	-	-	-	-	-	+	+	+	(+)	+	
a 2	~(+)	~(+)	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	A ¹ B ²
9	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	
11	(+)	(+)	~(+)	-	-	-	-	-	-	-	-	-	+	+	+	+	~(+)	
12	-	-	-	-	-	-	-	-	-	-	-	-	~(+)	+	+	+	+	A ² B ¹
3	-	-	-	+	+	~(+)	~(+)	+	+	~+	+	~(+)	-	-	-	-	-	
5	-	-	-	(+)	+	+	+	+	+	+	+	+	-	-	-	-	-	
7	-	-	-	(+)	+	+	+	+	+	+	+	+	-	-	-	-	-	
10	-	-	-	+	(+)	~(+)	~(+)	(+)	+	+	+	+	-	-	-	-	-	
16	-	-	-	+	+	(+)	+	+	+	~(+)	+	+	-	-	-	-	-	
	A ¹ B ¹			A ² B ²					A ¹ B ²				A ² B ¹					
1	-	-	-	r	F	-	-	F	-	-	-	-	-	-	-	-	-	A ¹ B ¹
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
13	-	-	-	F	r	-	-	F	-	-	-	-	-	-	-	-	-	
4	r	-	F	-	-	-	-	-	-	-	-	-	-	f*	-	F	-	A ² B ²
8	F	-	r	-	-	-	-	-	-	-	-	-	-	f	-	-	-	
14	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	f	-	
15	-	-	-	-	-	-	-	-	-	-	-	-	-	r	F	-	-	
17	F	-	F	-	-	-	-	f*	-	-	-	-	-	f	F	-	F	
b 2	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	r	-	A ¹ B ²
9	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	r	-	
11	-	-	-	-	-	-	-	-	-	-	f*	-	-	F	-	f	F	
12	-	-	-	-	-	-	-	-	-	-	-	-	-	r	F	f	F	A ² B ¹
3	-	-	-	-	-	-	-	f	-	-	r	-	-	-	-	f	-	
5	-	-	-	f*	f	F	-	F	F	F	f	r	-	-	-	-	-	
7	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	
10	-	-	-	F	-	f	-	-	r	r	F	f	-	-	-	-	-	
16	-	-	-	-	-	-	-	F	-	-	f	-	-	-	-	-	-	
	1	6	13	4	8	14	15	17	2	9	11	12	3	5	7	10	16	

が親菌糸に融合していない、いわゆる偽クランプがしばしば形成されることが、*Coprinus*, *Psathyrella*, *Peniophora* などの属について報告されている (Brunswick 1924; Oort 1930; Vándendries 1930; Quintanilha 1933; Biggs 1938)。しかし Aschan (1954) の観察によれば、エノキタケにおいては、このような偽クランプは全く見られなかったという。筆者のこれまでの観察では、稀に偽クランプを思わせる不完全構造も見掛けられたがこれは legitimate の交配の場合にも現れるのであって、illegitimate を特徴づけることにはならない。何れにしても、この異常構造の出現頻度は極めて低く、殆んどものは正常なクランプを形成するのである。境界線のみ二核化が行われる場合に見られるクランプは、両側或は片側に行われる組合せのものに比べて、通常小さく、また時として極めて少数しか形成されない場合もあったけれども、これらは殆んど常に真正のクランプであった。

ii) 子実体形成能： クランプの発生がみられた全ての組合せについて、子実体形成の能力を調査した。この実験は 1956 年 10 月上旬から年末までの 3 ヶ月間行ったが、この際に子実体の形成をみなかった組合せについては、改めて 1957 年 1 月上旬から 3 月末まで同じ実験を繰返した。この再度にわたる調査の結果は Table 1 b に示す通りである。尙、実験期間中の室温は、大体 15°C 以下であったが、これは本菌の子実体形成には適した温度条件であると考えられる。表中の“F”は、Figs. 1, 2 に示すような、菌傘の発達良好、孢子形成の豊富な正常型の子実体発生を表わす。これに反し“f”は、Fig. 4 のように、菌傘の展開が充分でなく、孢子を形成しないか或いはしても極めて少ないような、不完全な子実体の形成を示す。また Fig. 3 のように、菌傘が相当に発達し、一見正常型を思わせる外観を呈していても、肝心の孢子形成に異常がみられるものも、同じく“f”で示した。更に、子実体の原基は形成するが、その後の発生を示さなかった組合せは“r”で表わした。2 度の実験において、子実体形成がみられなかった組合せは“—”で示されている。Table 1 a と b を比較してみると、完全な子実体“F”の形成は、交配が legitimate であるか否かに拘らず、“+” (完全二核化) の組合せでのみ行われ

るのであって、“(+)” (限定二核化) の組合せでは、うまくいっても精々“f”止りであることが分る。尤も、子実体を正常に形成して然るべきだと考えられる“+”の組合せにおいて、2 度の培養実験にも拘らず依然として未形成を示すものが可成りあった。この原因については今後更に検討しなければならないが、とにかく、子実体形成能は二核化の“在り方”によって決定されるもののようで、その交配が legitimate であるか illegitimate であるかは問題でない、ということが一応云えるのではなからうか。

iii) illegitimate の交配より生じた子実体について： 上述のように、illegitimate の交配でも、その二核化が完全に行われてさえおれば、legitimate の組合せと同じように、正常な子実体を容易に形成することが可能である。Quintanilha (1935) も、*Schizophyllum* の illegitimate 交配において子実体の形成を報告しているが、これには legitimate のものよりもかなり長い期間を要している。しかし筆者の場合は、何れのものよりも最も早く (約 1 月後に) 発育の旺盛な完全子実体を形成したのは、legitimate の組合せではなくて、実に illegitimate の組合せ (5×17) であったことは注目に値する。また形成された孢子の数は Fig. 1 の spore deposit (矢印) で示されているように極めて豊富であり、孢子の大きさも legitimate の交配からのものと殆んど変らない。例えば、illegitimate 7×17 より生じた孢子の大きさは長径 $5.9 \pm 0.8 \mu$ 、短径 $3.5 \pm 0.6 \mu$ であり、legitimate 10×11 から得られた孢子は長径 $6.0 \pm 0.8 \mu$ 、短径 $3.5 \pm 0.8 \mu$ であった。この値は何れも孢子落下後 2 週間目の乾燥状態における、各組 50 個づつの平均値である。更に孢子の発芽率も、両交配の間で著しい差異はみられなかった。例えば、上記の illegitimate 7×17 から得られた孢子の、馬鈴薯蔗糖寒天上における 25°C 、24 時間培養時の発芽率は、孢子数 522 個について 92.3% であった。これは同一条件における legitimate 5×9 の発芽率、1671 孢子につき 94.3%、と比較して遜色のない高率ということができよう。尙、供試した孢子は各組とも、24 時間以内に放出された新鮮なものであった。

iv) 単相子実体： エノキタケにおいては、一核菌糸体が二核化の過程を経ることなく、それ自身

で単相の子実体を形成する場合のあることが、Zattler (1924) 及び Brodie (1936) によって報告されている。先に筆者(1954)も、本菌の *Nagao 3021* 系統について単相子実体の形成を認めたが、更に今回も *NL-55* 系統においてこの現象がみられた。Table 1b において * 印で示したのがそれで、この場合には、*3021* 系統に比べて、比較的外観の整った子実体が形成された。特に 4×5 の交配から 5 側に発生した子実体 (Fig. 3) は、可成り菌傘の展開もよく、一見したところ二核性の子実体を思わせるが、形成された胞子の数が極めて貧弱であった。この子実体から 15 個の単胞子を分離して、交配型を調査したところ何れも 5 のタイプであり、単胞子菌糸体 5 により単独に形成された単相子実体であることを物語っている。また Fig. 4 で示されるような発生程度の子実体からは胞子が得られないので、このような場合には、子実層の組織片を培養して、再生してきた菌糸体についてクランプ形成の有無を検鏡し、更にその交配型を調べて、単相であることを確認する方法を採った。現在までに扱った範囲では、単相子実体にはその外観が畸型を呈するものから、殆んど正常型に近いものまで、種々の段階のものが観察されたが、何れも胞子の形成が頗る悪いが、さもなくば全く形成されないことが注目された。

考 察

Aschan (1954) は、illegitimate の交配では、2 組考えられる組合せの“双方に”において、限定二核化が規則正しく行われることを報告しているが、完全二核化は何れの組合せにも全くみられなかったという。それ故、もしクランプの調査が境界線についてのみ行われた場合には、二極性の mating pattern を示すことになるが、更に調査を境界線の両側にまで及ぼせば、みせかけの二極性の仮面にかくされていた本来の四極性の正体が明るみに浮び上がってくるのである。また、illegitimate の交配からは、胞子形成を行うような正常な子実体の発生はみられなかったという。

これに反し、筆者の場合には、Table 1 で示されているように、illegitimate の組合せ $A^1B^1 \times A^1B^2$ (A^1 ホモ) では二核化がおこらないか、或は行われても精々限定二核化であって、満足な子実体を形成しないのに対して、もう一つの illegiti-

mate の組合せ $A^2B^1 \times A^2B^2$ (A^2 ホモ) においては、大部分のものが完全二核化を行い、更に完全な子実体すら形成するのである。この結果、二極性と四極性の正に“中間をゆく” mating pattern を示すのである。この型を“中間極性 inter-polarity”と名付けたい。Whitehouse (1949) が述べているように、四極性が二極性より進化して来たものだと考えれば、筆者の“中間極性”はさしずめその橋渡しの段階に位置するものということが出来よう。

最後に実験誤差の問題について検討したい。それは、 A^1 ホモの illegitimate の組合せでは二核化が極めて不完全であったにも拘らず、 A^2 ホモの場合には恰も legitimate の組合せと同じ完全な二核化と子実体形成がみられたことは、 A^2B^1 の交配型に A^1B^1 が、或は A^2B^2 に A^1B^2 が“混入”した結果ではないかとの疑問が生ずるからである。確かにエノキタケの胞子は上記の通り微小であり、また被膜は着色していないため、単胞子分離の際、誤って 2 個の胞子を拾うおそれがない。また本菌は発芽可能の oidia を形成するので、これが何かの拍子に紛れ込まないとも限らない。こういう幾分かの危険性が考えられるため、実験に際しては特に慎重な態度で臨んでいる。これまでの経験から推して、これらの実験誤差は精々 2% 以内に止まるものと思われる。而も、“混入”は各交配型の間で at random に行われるものであるから、上記のように A^2B^1 中に必ず A^1B^1 が、或は A^2B^2 中に決って A^1B^2 が、というように都合よく混入するケースは極めて少いことが予想される。事実この場合の確率は、実験誤差が 2% の場合には 10^{-6} 、また仮に誤差を 5% と大きくみても精々 10^{-5} というオーダーである。このことから考えても、 A^2 ホモの組合せにみられる完全な illegitimate dikaryotization は偶然の実験エラーによるものではなく、それ自身充分な意味と必然性を以て行なわれているものと結論して大過ないと考えられる。実験的に証明するには、この F_1 を追求してみればいいわけである。これについては、既に分析済みであり、他交配型の混入による乱れではないとの確証を得ているが、詳細は V 報に譲ることとする。

本研究に際し当教室の猪野俊平教授並びに木村

劫二助教授から、絶えざる御鞭撻と種々の御便宜をいただいた。また確率の問題については、当学部

数学教室の竹之内脩博士の御教示を仰いだ。これらの方々に対して深甚の謝意を表す次第である。

Summary

The so-called illegitimate dikaryotization occurs in the strain *NL-55* of *Collybia velutipes*. As seen in Table 1, the dikaryotization occurring in the illegitimate combination $A^1B^1 \times A^1B^2$ (homozygous for A^1) is uncertain or limited in the contact zone between two mated mycelia, normal fruit-bodies being not formed at all. On the contrary, in the other illegitimate pairing $A^2B^1 \times A^2B^2$ (homozygous for A^2) both dikaryotization and fruit-body formation take place as completely as in legitimate mating. In the latter case, the possibility of contamination of the adequate spores or oidia may be eliminated on the basis of the law of probability. Thus the just "intermediate" mating pattern between bipolar and tetrapolar ones results, which is called "interpolarity" in the present paper. The significance of the "interpolarity" is briefly discussed from the view-point of evolution.

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エノキタケの遺伝学 V

NL-55 系統における F₁ の交配模様*

武 丸 恒 雄**

Tsuneo TAKEMARU**: Genetics of *Collybia velutipes*, V. Mating Patterns between F₁-mycelia of Legitimate and Illegitimate Origins in the Strain NL-55*.

昭和 32 年 5 月 13 日受付

IV 報では、本系統の子実体 55P から分離された 17 単孢子菌糸体間の交配において、二極性と四極性の中間を行く、いわゆる“中間極性”がみられたことを発表した。引続いてその F₁ における交配模様を追求したところ、興味ある結果が得られたので報告する。

材料及び方法

上記の 17 単孢子菌糸体を親として、その間で legitimate および illegitimate の交配を行い、それによって形成された子実体から、それぞれの F₁-単孢子菌糸体を分離して実験に供した。一連の実験方法は IV 報で述べたのと全く同じである。

実験結果

I. legitimate F₁ の交配模様

i) 子実体 59 の分析: 本子実体は、両親菌糸体 5(A²B¹) と 9(A¹B²) の交配より得られたものである。常法によって分離された単孢子菌糸体 18 系統について、あらゆる組合せで交配を行ったところ、Table 1 に示されているような交配模様が得られた。表中の記号“(+)”は、クランプの形成が交配された両菌糸体間の境界線においてのみ行われる限定二核化を表わし、“+”は、クランプが境界線に止まらずその両側にも形成される完全二核化を示している。いずれの部位にもクランプ形成がみられなかった組合せは“-”で表わされる。

これらの記号は、以下の表においても同じ意味に使用されるだろう。F₁-菌糸体の交配型は、親系統の各交配型を代表する 4 テスター菌糸体に戻交雑することによって同定された。Table 1 に示された交配模様は、正しく Aschan (1954) が本菌について報告した模様と同じものであって、illegitimate の組合せでは規則正しく限定二核化が行われ、“中間極性”の傾向はこの範囲では見られなかった。

ii) 子実体 18 の分析: この子実体は両親菌糸体 1(A¹B¹) × 8(A²B²) の交配により生じたものである。分離された 16 単孢子菌糸体間の交配模様は Table 2a に示された通りである。Table 2b は、上記 16 F₁-菌糸体を、親系統の 8 テスター菌糸体に戻交雑した結果を表わしている。Table 2 から明らかなように、この場合には、親系統 55P においてみられたと同様の“中間極性型の”交配模様が再び現われたのである。更に注意を惹かれるのは、illegitimate A²B¹ × A²B² の交配模様である。これから考えられることは、A²B¹ および A²B² の交配型はいずれもそれ自身単一の型ではなくして、実は I, II, III で表わされる 3 つの型に細分されねばならない複合型である、ということであろう。

II. illegitimate F₁ の交配模様

i) 子実体 717 の分析: 本子実体は、両親菌糸体 7(A²B¹) × 17(A²B²) の交配より形成され

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たものである。分離された 14 F₁-単胞子菌糸体間の交配模様は、Table 3 a に示された通りである。Table 3 b は、親系統からの 8 テスター菌糸体に戻交雑を行い、F₁-菌糸体の交配型を同定した時の模様を示している。これらの表から理解できるように、A²B¹ および A²B² 交配型は、子実体 18 においてみられたと同様の複合型であり、この場合には、両交配型のそれぞれの Subtypes I および II の間で、結局四極性型の交配模様を示したものと考えられる。

ii) 子実体 410 の分析： この子実体は、両親菌糸体 4(A²B²)×10(A²B¹) の交配より発生したものである。12 F₁-単胞子菌糸体間の交配模様は、Table 4 に表わされているように、子実体 717 と同様、再び四極性型を示した。

考 察

上記の実験結果は、不和合性因子の本質を察知

する一つの手掛りを提示しているものと考えたい。

従来、A, B などでは表わされる不和合性因子は、それぞれ単一の座を占める複対立遺伝子から構成されたものであると考えられていた。併し、最近 Papazian (1951) は、これらの因子は何れも 2 あるいはそれ以上の座における複対立遺伝子を包含するポリジーン系であるとの見解を発表した。筆者の実験結果は、彼の見解を支持するものだと考えられる。即ち、A 因子が、同一のリンケージ群に属する 2 対の対立遺伝子 (A₁¹, A₂¹) および (A₁², A₂²) から構成され、その間で乗換えが行われるものと考えれば、上記の実験結果を合理的に説明しうるからである。Fig. 1 はその模型図である。今、乗換えによって生じた 2 つの組換え型 A₁¹A₂² と A₁²A₂¹ が A² 因子として働くものと仮定すれば、親型の A₁²A₂² と併せて、結局 A² 因子には 3 つの異なる遺伝子型が存在することになる。

Table 1. Tetrapolar mating pattern between 18 F₁-monosporous mycelia from the legitimate pairing 5×9 of the parent strain 55P. The sign “+” denotes complete dikaryotization on both sides of the contact zone, and the sign “(+)” indicates limited dikaryotization found only in the contact zone between two mated mycelia.

	8	12	23	24	25	2	6	7	10	1	11	20	27	3	9	21	22	26		
8	-	-	-	-	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-	A ¹ B ¹	
12	-	-	-	-	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-		
23	-	-	-	-	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-		
24	-	-	-	-	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-		
25	-	-	-	-	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-		
2	+	+	+	+	+	-	-	-	-	-	-	-	-	(+)(+)(+)(+)(+)	-	-	-	-	A ² B ²	
6	+	+	+	+	+	-	-	-	-	-	-	-	-	(+)(+)(+)(+)(+)	-	-	-	-		
7	+	+	+	+	+	-	-	-	-	-	-	-	-	(+)(+)(+)(+)(+)	-	-	-	-		
10	+	+	+	+	+	-	-	-	-	-	-	-	-	(+)(+)(+)(+)(+)	-	-	-	-		
1	(+)(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	A ¹ B ²	
11	(+)(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+		
20	(+)(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+		
27	(+)(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+		
3	-	-	-	-	-	(+)(+)(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-	A ² B ¹	
9	-	-	-	-	-	(+)(+)(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-		
21	-	-	-	-	-	(+)(+)(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-		
22	-	-	-	-	-	(+)(+)(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-		
26	-	-	-	-	-	(+)(+)(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-		
	A ¹ B ¹					A ² B ²					A ¹ B ²					A ² B ¹				

Table 2, a) "Interpolar" mating pattern occurring between 16 F₁-mycelia from the fruit-body 18 of legitimate origin. b) Pairing pattern between the 16 F₁-mycelia and 8 tester-mycelia from the parent strain 55P.

The mating types *A²B¹* and *A²B²* may be divided into three subtypes I, II and III, respectively. Genic constitutions of these subtypes and mating pattern between them are given in Table 5.

		2	3	4	8	14	1	5	7	15	11	16	6	9	10	12	13		
a	2	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-	A^1B^1	
	3	+	-	-	-	-	-	-	-	-	(+)(+)	+	+	+	+	+	+	I	
	4	+	-	-	-	-	-	-	-	-	+	+	(+)(+)(+)(+)	(+)(+)(+)(+)	+	+	II		
	8	+	-	-	-	-	-	-	-	-	+	+	(+)(+)(+)(+)	(+)(+)(+)(+)	+	+	II		
	14	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	(+)	III	
	1(+)	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	A^1B^2	
	5(+)	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+		
	7(+)	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+		
	15(+)	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+		
	11	-	(+)	+	+	+	+	+	+	+	+	-	-	-	-	-	-	I	
	16	-	(+)	+	+	+	+	+	+	+	+	-	-	-	-	-	-		
	6	-	+	(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-	-	II	
	9	-	+	(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-	-		
	10	-	+	(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-	-		
	12	-	+	(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-	-		
13	-	+	+	+	+	(+)	+	+	+	+	-	-	-	-	-	-	III		
		I			II			III			I			II			III		
		A^1B^1			A^2B^2			A^1B^2			A^2B^1			A^2B^1					
		I			II			III			I			II			III		
b	1	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-	A^1B^1	
	6	-	+	+	+	+	(+)(+)(+)(+)	-	-	-	-	-	-	-	-	-	-		
	4	+	-	-	-	-	-	-	-	-	(+)(+)	+	+	+	+	+	+	I	
	17	+	-	-	-	-	-	-	-	-	+	+	(+)(+)(+)(+)	(+)(+)(+)(+)	+	+	II		
	2	(+)	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	A^1B^2	
	11	(+)	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+		
	7	-	(+)	+	+	+	+	+	+	+	+	-	-	-	-	-	-	I	
	10	-	+	(+)(+)	+	+	+	+	+	+	+	-	-	-	-	-	-	II	
		2	3	4	8	14	1	5	7	15	11	16	6	9	10	12	13		

Table 3. a) Tetrapolar mating pattern between 14 F_1 -mycelia from the fruit-body 717 of illegitimate origin ($A^2B^1 \times A^2B^2$). b) Pairing pattern between the F_1 -mycelia and 8 tester-mycelia from the parent strain 55P.

The mating types A^2B^1 and A^2B^2 may be divided into two subtypes I and II, respectively.

		1	9	6	8	12	14	5	10	11	13	2	3	4	7		
a	1	-	-	-	-	-	-	(+)	(+)	(+)	(+)	+	+	+	+	I	A^2B^1
	9	-	-	-	-	-	-	(+)	(+)	(+)	(+)	+	+	+	+		
	6	-	-	-	-	-	-	+	+	+	+	(+)	(+)	+	(+)		
	8	-	-	-	-	-	-	+	+	+	+	(+)	(+)	-	(+)		
	12	-	-	-	-	-	-	+	+	+	+	(+)	-	(+)	+	II	
	14	-	-	-	-	-	-	+	+	+	+	(+)	(+)	(+)	(+)		
	5	(+)	(+)	+	+	+	+	-	-	-	-	-	-	-	-	I	A^2B^2
	10	(+)	(+)	+	+	+	+	-	-	-	-	-	-	-	-		
	11	(+)	(+)	+	+	+	+	-	-	-	-	-	-	-	-		
	13	(+)	(+)	+	+	+	+	-	-	-	-	-	-	-	-		
	2	+	+	(+)	(+)	(+)	(+)	-	-	-	-	-	-	-	-	II	
	3	+	+	(+)	(+)	-	(+)	-	-	-	-	-	-	-	-		
	4	+	+	+	-	(+)	(+)	-	-	-	-	-	-	-	-		
	7	+	+	(+)	(+)	+	(+)	-	-	-	-	-	-	-	-		
		I				II				I				II			
		A^2B^1								A^2B^2							
b	Tester mycelia from 55P	1	9	6	8	12	14	5	10	11	13	2	3	4	7		
	1	-	-	-	-	-	-	+	+	+	+	+	+	+	+	I	A^1B^1
	6	-	-	-	-	-	-	+	+	+	+	+	+	+	+		
	4	(+)	(+)	+	+	+	+	-	-	-	-	-	-	-	-	I	A^2B^2
	17	+	+	(+)	(+)	(+)	(+)	-	-	-	-	-	-	-	-		
	9	+	+	+	+	+	+	-	-	-	-	-	-	-	-	I	A^1B^2
	11	+	+	+	+	+	+	-	-	-	-	-	-	-	-		
	7	-	-	-	-	-	-	(+)	(+)	(+)	(+)	+	+	+	+	I	A^2B^1
10	-	-	-	-	-	-	+	+	+	+	(+)	(+)	(+)	(+)			
		I				II				I				II			

考慮に入れば、多少の修正が必要となる。即ち、“真の” illegitimate の組合せは、Table 5 中 (+) で示された限定二核化の場合だけに局限されるわけで、他の完全二核化+の組合せは全て“みせかけの” illegitimate にすぎなく、本質的には legitimate であることになる。従って、IV 報 (Takemaru 1957) で報告したように、親系統 (55P) のいわゆる illegitimate 交配 $A^2B^1 \times A^2B^2$ において、完全な二核化と正常な子実体形成を行う組合せもみられたことは、決して偶然でも実験エラーによるものでもなく、それ自身充分な必然性を以て生じたものだと考えられる。それ故、これらの交配から発生した子実体 717 (Table 3) および 410 (Table 4) は、本質的には legitimate origin

のものであり、その F_1 -菌糸体間で四極性型の交配模様を生じたことは、誠に当然の結果だと考えられるのである。いわゆる illegitimate F_1 -菌糸体については、既に Oort (1930), Quintanilha (1935) などが *Coprinus* 属において分析しているが、彼等によれば、illegitimate の交配から形成された子実体は全て単相起源のものであるという。しかし、上述のように、不和合性因子が少くともリンクした2座における対立遺伝子によって構成されているとの見解から見れば、いわゆる illegitimate 子実体は全て本質的にハプロイドであると結論し去ることには一考を要するのではなかろうか。

Summary

Mating patterns between F_1 -monosporous mycelia of legitimate and illegitimate origins in the strain *NL-55* (fruit-body 55P) have been studied.

The tetrapolar mating pattern as reported by Aschan (1954, p. 612) has occurred between legitimate F_1 -mycelia (Table 1). Between the other legitimate F_1 -mycelia (Table 2), however, the “interpolar” mating pattern as found in the parent strain 55P (Takemaru 1957) has appeared again.

From the pairings between illegitimate F_1 -mycelia, typical tetrapolar pattern has resulted (Tables 3 and 4).

These experimental results suggest, as already described by Papazian (1951), that the *A* incompatibility factor is controlled by at least two linked genes.

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Preventative Effect of Sugars on the Pollen Degeneration of Wheat Plant*

by Hirosuke FUKASAWA**, Katsuhiro MITO** and Masanobu FUJIWARA**

深沢広祐**・三藤勝弘**・藤原正信**：コムギ花粉の退化に対する糖の阻止的
作用について*

Received April 8, 1957

Introduction

Emmer wheat with the cytoplasm of *Aegilops ovata* obtained by means of successive backcrosses is characterized by its male-sterility (Fukasawa, 1953). Cytological investigation on the pollen degeneration in the sterile anthers, shows that microspore development proceeds normally with complete pairing of 14 bivalents at meiosis. After liberation from tetrads the microspores fail to develop, degenerating in the course of pollen mitosis (Fukasawa, 1956).

A similar degeneration of pollen grains can be induced artificially in normal wheat plants. For example, when stalked young spikes with two leaves are cut off at the stage of pollen mitosis and placed in the dark for about one week, white spikes without chlorophyll emerge from the leaf-sheath, and no good pollen grains are formed (Fukasawa, 1956). The degree of pollen degeneration in the dark increases extremely when the plant is cut off at the meiotic stage. The present report deals with the experimental results concerning the restoration of pollen formation by supplying sugar to the culture solution in the dark, and a preliminary attempt to resolve the mechanism of pollen degeneration in cytoplasmic male-sterile wheat. In addition the study deals with an attempt to prevent the degeneration of pollen grains in the male-sterile wheat, and a paper chromatographic analysis to survey the sugars present in male-sterile and normal anthers.

Materials and Methods

The wheat plants used in the present investigation are *Triticum durum* var. *Reichenbachii* and two male-sterile strains with the cytoplasm of *Ae. ovata*, namely, male-sterile *durum* and male-sterile *dicoccum* (Khapli). These plants were planted in the field. Stalked young spikes enveloped in the leaf-sheath were, with two leaves, cut off at the meiotic stage, and placed in a bottle with Shive's solution.

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Normal spikes of *T. durum* were cultured in the dark at room temperature for about one week or more. Sugars added in the culture solution were glucose, fructose or sucrose in a concentration of 5 % or 7 %. Male-sterile spikes were placed in daylight at room temperature, adding such sugars to Shive's solution or tap water as 0.5 %, 1 %, 3 % and 5 % sucrose, 3 % glucose or 0.5 % and 1 % fructose.

Pollen grains were investigated by staining with dilute aceto-carmin solution to detect any abnormality in nuclear division and cytoplasmic anomalies in the course of sporogenesis. Various types of pollen degeneration were classed in the following five grades according to Kihara (1937). Namely: class-I, normal good pollen with one vegetative nucleus and two generative nuclei; class-II, pollen grains with three not fully differentiated nuclei; class-III, two nucleate pollen; class-IV, one nucleate pollen; class-V, empty pollen.

The survey of sugars in the anthers was made by means of ascending one-dimensional paper-chromatography. Sample solutions were prepared by extracting the anthers with 50 % ethyl alcohol. Development of sugars was carried out by the use of a mixture of *n*-butanol, acetic acid and water (5:1:2). After the filter paper was dried at room temperature, it was sprayed with alcoholic benzidine solution (benzidine 0.5 g., acetic acid 10 cc., absolute alcohol 80 cc., and 40 % trichloroacetic acid 10 cc.) and heated until the clear brown spots appeared.

Experimental Results

1) Normal plant of *T. durum* in the dark.

When the stalked spikes of normal plant of *T. durum* were placed in the dark, they grew very slowly and, the green color of their leaves and leaf-sheaths faded gradually. White and tender spikes emerged after one week or more. However, when 5 % glucose, sucrose or fructose was added to the culture medium, they grew more rapidly than the control without sugar (Fig. 1); the decoloration of the leaves and sheaths was also less conspicuous than with the control plants, and the heads were composed of rather tough spikes with a light yellow color.

Results of investigation of pollen grains obtained from these spikes are presented in Table 1. Normal plants growing in the field were found to produce as much as 95 % good pollen grains, whereas on the plants cultured in the dark, most of microspores became either one-nucleate (class-IV) or empty (class-V). Good pollen (class-I) was not produced at all. However, when sugar (glucose or sucrose) was added to the culture solution, a considerable amount of good pollen grains was produced (Table 1). For example, the spikes grown in 5 % sucrose solution produced as many good pollen grains (92 %) as the normal spikes growing in the field. When 7 % glucose was used, 59 % of the microspores grew into good pollen grains of class-I, 26 % were class II, the rest of them belonged to the class-III, -IV, and -V. In order to confirm the results obtained in the above experiment (exp. 1,

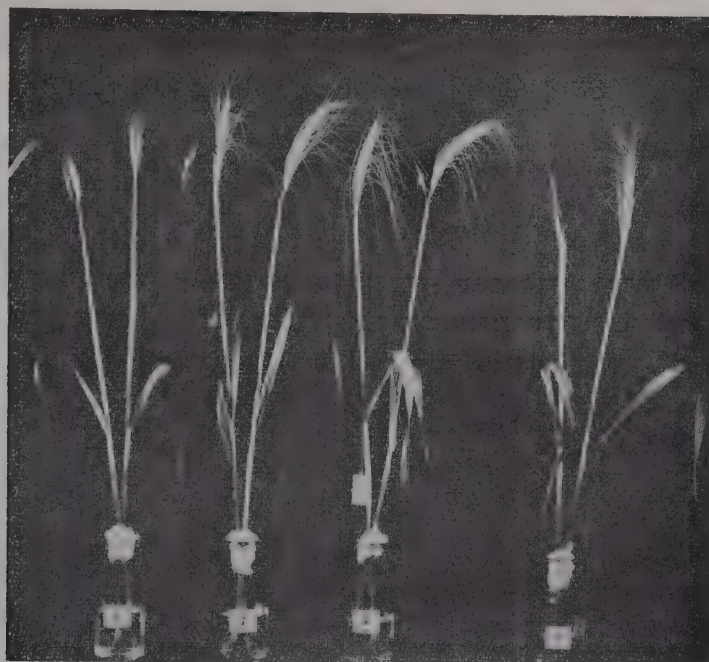


Fig. 1. Dark-grown spikes of *Triticum durum*. C: control (no sugar), S: sucrose, G: glucose, F: fructose

Table 1. Pollen analysis in the dark-grown spikes of *Triticum durum*

Experiment no.	Culture conditions	Pollen classes				
		I	II	III	IV	V
1 (May 9, 1956)	In field	95.4%	0.4%	2.7%	0.9%	0.6%
	Tap water in the light	92.4	0.6	3.2	2.2	1.6
	Control (no sugar)	0	0.5	12.4	47.1	40.0
	5 % sucrose	92.1	4.4	2.8	0.2	0.5
	7 % glucose	58.6	25.6	8.7	3.4	3.7
2 (June 4, 1956)	5 % sucrose	37.3	44.2	13.1	4.4	1.0
	7 % "	18.1	43.3	32.2	4.4	2.0
	5 % glucose	0	11.8	78.4	9.3	0.5
	7 % "	0.2	14.4	78.4	6.8	0.2
3 (June 15, 1956)	5 % sucrose	44.4	37.1	13.8	3.9	0.8
	5 % glucose	2.6	35.7	56.6	3.1	2.0

Table 1), two sets of experiments were performed in June, with the intention of deciding whether sucrose or glucose was more effective in ameliorating the development of microspore. The results (exp. 2 and 3, Table 1) showed the same trend of restoration of normal pollen production although the yield of good pollen (class-I) was not always as marked as in the earlier experiment. The low fertilities in

the 2nd the 3rd experiments may be due to the inappropriate condition of the test plants investigated here in rather late season. Five percent sucrose was, however, found more suitable for the production of good pollen grains than 7 % sucrose, 5 % glucose or 7 % glucose.

2) Male-sterile *durum* plant in the daylight.

When the stalked young spikes of male-sterile *durum* plant were cultured in the daylight, as seen in Fig. 2, the spikes in sucrose solution grew better than those in the medium without sugar, having almost the same appearance as in a normal spike of *T. durum*. Pollen analysis was made with such a male-sterile spikes. Pollen grains from male-sterile *durum* plants growing in the field showed a higher degree of degeneration in this season than in the previous year (cf. Table 1, Fukasawa, 1956), i. e., a large number of pollen was empty and no good pollen of class I and II was observed (there were about 2 % class-II pollen last year). The addition of sugar to the medium was found to be efficacious to some extent in improving the pollen status of those male-sterile wheat plants, although no first class pollen (class-I) was actually produced by the treatment. The results are summarized in Table 2. The addition of fructose, glucose or sucrose to the culture solution decreased the percentage of empty pollen grains to about 30-40 % as compared to 70 % in the control without sugar. The yield of class-IV pollen was increased to about 50 % as compared to 25 % in the control. The percentage of class-III pollen was also increased by the artificial supply of sugars, especially sucrose. Somewhat better results were obtained with sucrose; in fact, the production of class-II pollen was narrowly realized. The ameliorative effect of glucose was about the same with male-sterile *dicoccum* plants.

3) Paper chromatography of sugars in the anthers.

From the above experimental results it was found that the addition of sugars to the culture medium prevents the pollen degeneration in normal wheat plants placed in the dark, and promotes pollen development in male-sterile anthers. Since sucrose seemed to be most favorable in promoting the normal pollen production, chromato-



Fig. 2. Male-sterile *durum* plant cultured in the daylight. W: control (tap water, no sugar), S: 3 % sucrose.

Table 2. Pollen analysis in male-sterile spikes grown in the daylight, adding sugars

Strains	Culture conditions	Pollen classes				
		I	II	III	IV	V
Male-sterile <i>durum</i>	In field	0%	0%	4.4%	25.7%	69.9%
	0.5 % fructose	0	0	9.9	56.0	34.1
	1.0 % "	0	0	2.1	57.7	40.2
	3.0 % glucose	0	0	9.6	62.0	28.4
	0.5 % sucrose	0	1.7	15.3	55.6	27.4
	1.0 % "	0	3.0	17.2	52.9	26.9
	3.0 % "	0	0	2.1	38.1	59.8
	5.0 % "	0	0.5	17.6	53.8	28.1
Male-sterile <i>dicoccum</i> (Khapli)	In field	0	0.1	21.7	32.4	45.8
	0.5 % glucose	0	3.6	20.1	54.2	22.1
	1.0 % "	0	1.4	20.4	49.3	28.9
	Control (no sugar)	0	0	1.3	3.3	95.4

graphic analysis of sugars in male-sterile and normal anthers was made with the purpose of detecting the possible differences in the sugar contents in normal and male-sterile anthers. Each sample of male-sterile *durum* and normal plants consisted of 200 anthers whose fresh weight was 45 mg. and 110 mg., respectively. Furthermore, maize anthers taken from cytoplasmic male-sterile and normal plants were tested by the same method as used for wheat anthers. Each maize sample consisted of 120 mg. material (fresh weight), which was 127 anthers in male-sterile

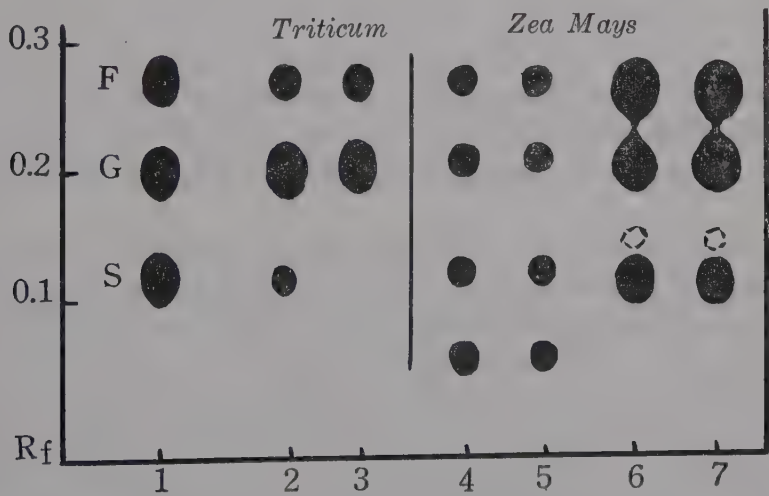


Fig. 3. Paper chromatograms of the sugars in male-sterile and normal anthers. 1; standard (F: fructose, G: glucose, S: sucrose), 2; normal wheat, 3; male-sterile wheat, 4; young anther of normal maize, 5; young anther of male-sterile maize, 6; mature anther of normal maize, 7; mature anther of male-sterile maize.

plants, and 42 in normal plants. After developing for 15 hrs. sugars were detected by spraying with benzidine solution. The results are presented in Fig. 3. Normal anthers of *T. durum* gave three spots, in which one small spot represented sucrose and two large spots fructose and glucose, respectively. Only two spots appeared in male-sterile *durum* anthers with no spot in the sucrose position. On the other hand, maize anthers gave spots for all three sugars, fructose, glucose, and sucrose, and both in male-sterile and normal anthers. Furthermore, young maize anthers produced four spots, of which three coincided with these described just above; another one appeared to be maltose.

Discussion

There are many reports about favorable effects of sucrose on the growth of vegetative organs in plant (Juhren and Went, 1949; Lee, 1950; Street and Lowe, 1950; Street and McGregor, 1952; Hildebrandt and Riker, 1953; Böhning, Kendall and Linck, 1953; Rietsema, Satina and Blakeslee, 1953; Frank and Kenny, 1955). However, the effect of sucrose on the development of generative organ has hardly been investigated. Iwanami (1954) reported that starch grains in the pollen of *Impatiens* increased in the medium with 5 % sucrose. In the present investigation, it was revealed that the pollen degeneration with wheat spikes placed in the dark was prevented by the addition of sugars to the culture medium. This leads us to the supposition that sugars are indispensable for the normal formation of pollen grains. Furthermore, since sucrose was more effective than the other sugars and since paper chromatographic analysis showed no sucrose spot in the male-sterile wheat anthers, it seems likely that the presence of sucrose is essential for normal development of the pollen grains. However, adding sucrose to the young spikes of the male-sterile *durum* plant did not result in the formation of good pollen grains, though some progress of pollen development was found. From these facts, it may be assumed that the pollen degeneration in cytoplasmic male-sterile wheats is caused not solely by the deficiency of sucrose in the anthers but also of other still unknown factors.

As the results of his paper chromatographic study, Fukasawa (1954) has reported the disappearance of proline and the remarkable accumulation of asparagine in the anthers of cytoplasmic male-sterile wheat and maize in the course of pollen degeneration. A similar relationship between proline and asparagine was also found in the flag-leaf of male-sterile *durum* plant, as well as in both anthers and flag-leaf in the normal plant of *T. durum* placed in the dark for one week or more (Fukasawa and Mito, 1956). Further investigation should be carried on to determine whether such a relationship between proline and asparagine in the male-sterile plant is directly connected with the sucrose deficiency described in the present study.

Summary

1) The present report deals with the preliminary investigations of the influence of sugar supply upon the pollen formation in wheat, in order to find a method of preventing pollen degeneration in cytoplasmic male-sterile anthers.

2) When young stalked spikes of normal wheat plant (*T. durum*) were cut off at the meiotic stage and placed in the dark, all microspores became abortive. Adding of sugars, especially 5 % sucrose, to the culture medium protected the pollen grains from degeneration, yielding good pollen almost to the same extent as in the normal plant growing in the field.

3) When a male-sterile *durum* plant (stalked spikes) was cultured in the daylight, adding of sucrose did not result in the production of good pollen grains, but some progressive features of pollen development were observed in cytological investigation.

4) Paper chromatography was used for the survey of sugars in male-sterile and normal wheat anthers. Normal anthers showed three spots: fructose, glucose and sucrose; while male-sterile anthers did not show the sucrose spot.

5) From these result, it was concluded that the lack of sucrose in the plant was one of the main causes of pollen degeneration in the cytoplasmic male-sterile wheat, although other still unknown factors might also be involved.

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The Effects of Colchicine and Auxin on Rhizoid Formation of *Dryopteris erythrosora*

by Yukio KATO*

加藤幸雄*: ペニシダの仮根形成に対するコルヒチン及びオーキシンの影響

Received April 13, 1957

It is a well known fact that auxin and colchicine affect both the growth of elongation and its morphological type. The author stated in a separate report of this series that in *Equisetum* indole acetic acid increases the number of rhizoids in the germinating spore, while in *Osmunda* it acts as a kind of inhibitor for the rhizoid formation (Kato, in press). The present study was undertaken to determine the effects of growth hormone (naphthalene acetic acid) and colchicine on rhizoid formation in *Dryopteris* spores. Regarding the influence of colchicine on young prothallium, Yamazaki (7) reported on *Polystichum craspedorum*, but not on the role of colchicine for the rhizoid-differentiation.

The spores used in the present experiment were taken from the leaves of *Dryopteris erythrosora* grown in the vicinity of Nagoya City. Spores were cultured for 15-20 days in one of the following concentrations of α -naphthalene acetic acid (NAA); 0.01, 0.1, 1, 10, 100 p.p.m. Aqueous solutions of colchicine were prepared in concentrations from 0.2 to 0.05 %. As control, 1/5 dilute Knop's agar medium was applied. The method used in the present experiment was the same as that described in the separate report.

Results

In the control medium, after seven days of culture, the first division of spores takes place and the rhizoids grow out of the exine membrane (Fig. 1g.)

1. The effects of NAA

In the NAA-containing medium (100 p.p.m.), the first division of spores is strongly inhibited and spores are greatly enlarged prior to the cell division. That is to say, spores grow not only longitudinally but also laterally. Cwing to this hypertrophy of spores, the exine membrane is frequently cast off (Fig. 1a). The spore elongates longitudinally and becomes oblong in shape.

In the control medium, the germinating spore becomes 9 or 10 cells in the 20-day-old material and the growth is usually in two dimensions. The spore cultured in the medium containing NAA often consists of a single elongated cell. No cell

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division occurs. Figure 1b shows the spore consisting of two cells without rhizoid-differentiation. The division seems to occur in a position perpendicular to the axis of polarity. Figure 1c shows also a spore without rhizoid. The new cell wall of the first division seems to be at right angles to the axis of polarity. Even if the rhizoids

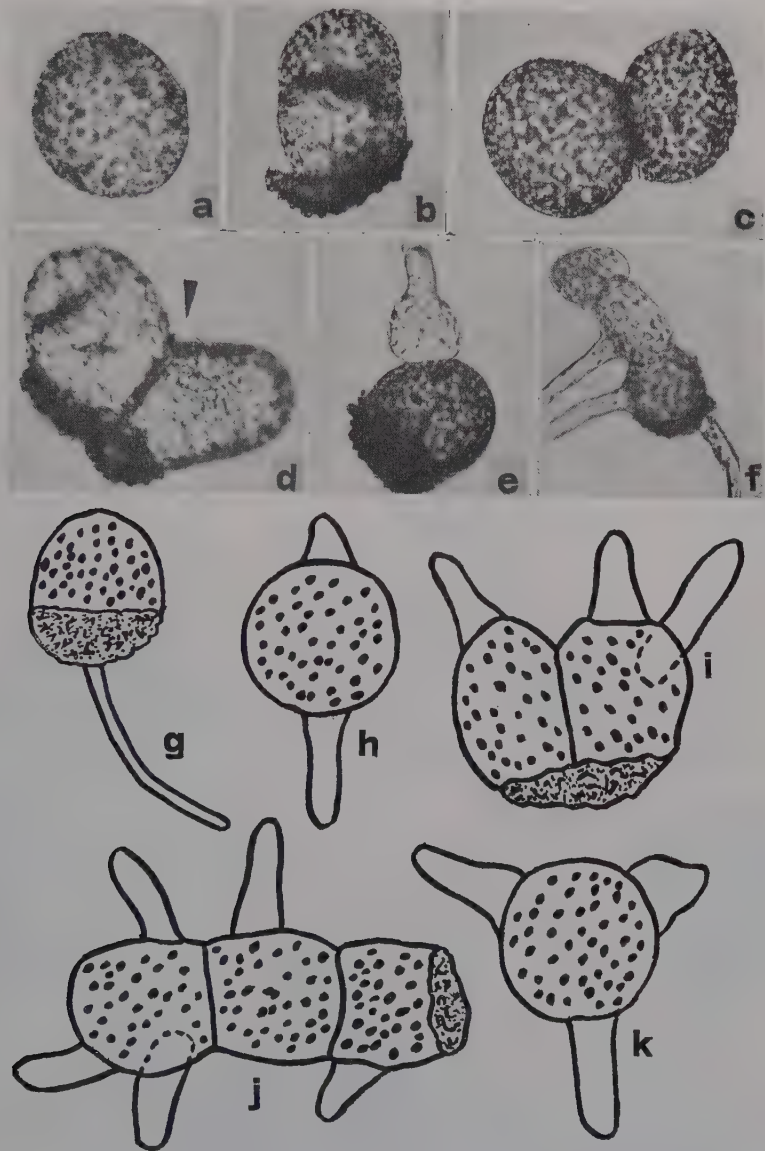


Fig. 1a-k. Effects of auxin (NAA) on rhizoid formation of *Dryopteris* spores. a, spore without rhizoid. Exine membrane is cast off because the spore enlarges greatly prior to the first division. b, two cell stage of protonema, without rhizoid formation. c, germinating spore without rhizoid. Exine membrane is cast off. d, germinating spore, appearing the lateral rhizoid from the protonema but not from the rhizoidal pole. e, germinating spore having swollen rhizoid. f, germinating spore with two lateral rhizoids. g, normally germinating spore. h-k, spores with swollen lateral rhizoids.

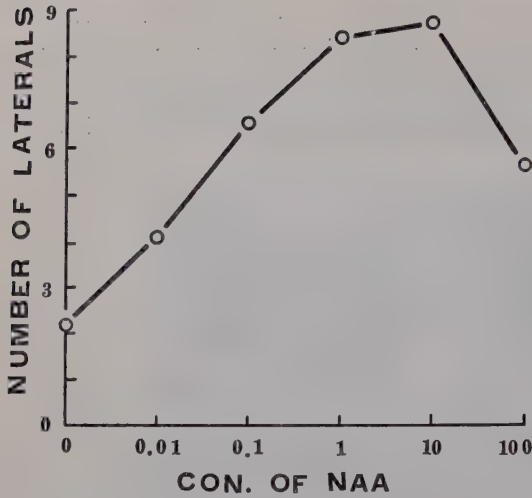


Fig. 2. Relation between concentrations of NAA and average number of lateral rhizoids per protonema (15-day-old material).

do differentiate, their elongation is extremely inhibited. Sometimes, the rhizoid is observed as a small protuberance (Fig. 1d). The swelling of the rhizoid is one of the effects of auxin (Fig. 1h-k). The rhizoid can originate not only from the rhizoidal pole but also from the protonematic pole (Fig. 1d and e). This may be regarded as a kind of lateral rhizoids rather than a reversal of the polarity. Lateral rhizoids are not usually formed up to the 5 or 6 cell stage of protonema in the control medium, while 1-5 laterals are formed even in the 1 or 2 cell stage in the NAA-containing medium.

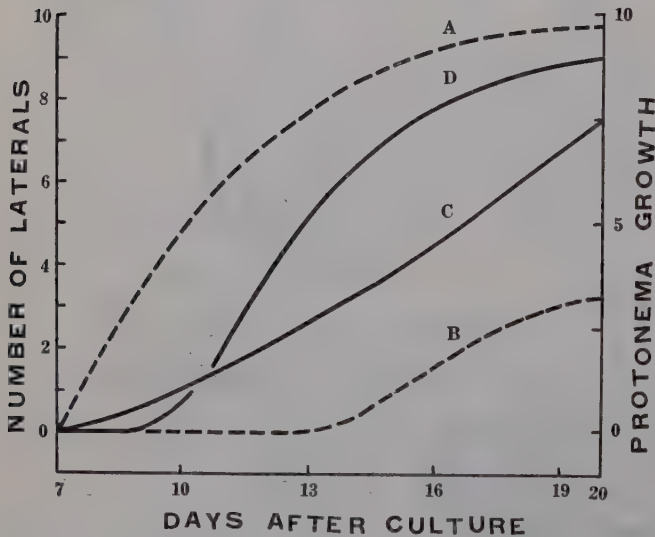


Fig. 3. Relation between protonema growth and average number of lateral rhizoids per protonema. broken line A...protonema. growth in the control medium. broken line B...average number of laterals. unbroken line C...protonema growth in the medium containing NAA (10 p.p.m.). unbroken line D...average number of laterals in the medium containing NAA.

The relation between the used concentrations of NAA and the average number of lateral rhizoids is shown in Figure 2. This result was obtained from the 15-day-old material. The number of laterals is greatly increased in concentrations of 0.1-10 p.p.m. of NAA. In Figure 3 the protonema growth and the average number of laterals in the control medium and in the medium containing NAA are shown. From the figure presented here, it may be concluded that in the control medium there is a parallel relation between protonema growth and the number of laterals, i.e., the more the proto-

nema grows or the cell number increases the more the average number of laterals per protonema increases. First laterals appear, for instance, on about the 15th day of culture, when the protonema grows to 8.7 mm. On the other hand, laterals emerge on the 9th day of culture, when the protonema grows to 0.5 mm in the medium containing NAA. As mentioned above, in an extreme case, a lateral rhizoid is formed even in one cell stage of an undivided spore (Fig. 1h and 1k). It is, therefore, evident that NAA acts as an effective inducer for the formation of lateral rhizoid. In conclusion, NAA-treatment of the germinating spores prevents the formation of rhizoid from the spore and promotes the formation of lateral rhizoid from the protonema. It is possible to assume that the formation of lateral rhizoid from the protonema is different from that of rhizoid from the spore in respect to the morphogenetic factor. NAA induces not only the swelling of rhizoid, but also of protonematic cells. Therefore, the growth and arrangement of protonematic cells are very irregular. The division axis of protonematic cells also varies in its pattern.

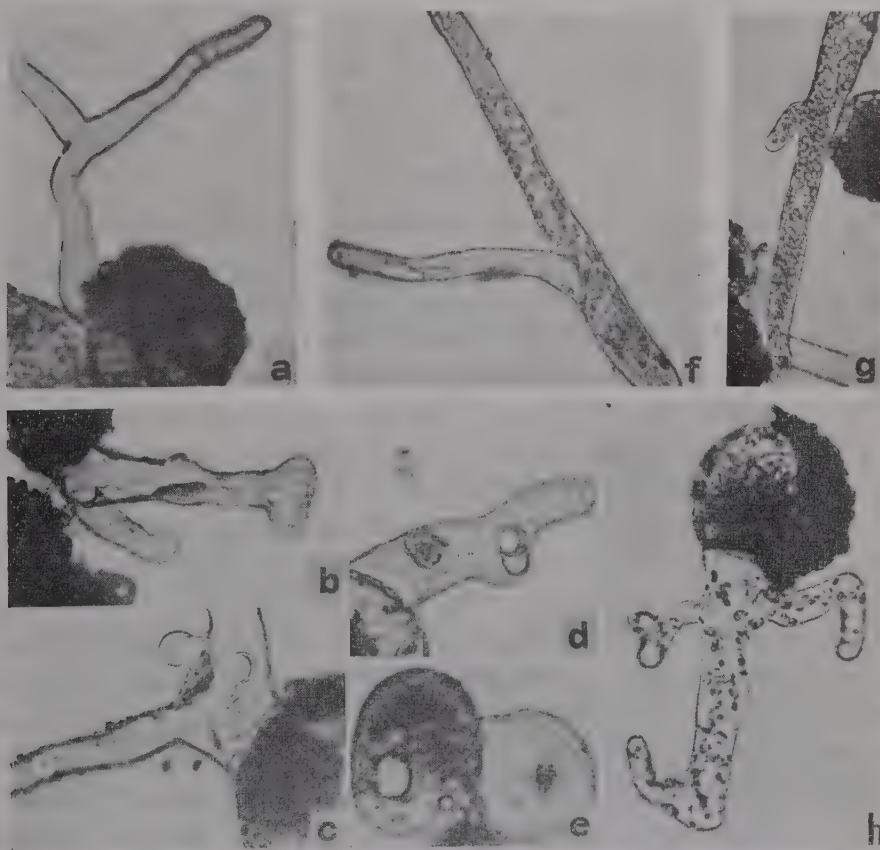


Fig. 4a-h. Abnormally branching rhizoids and rhizoidal protonemata induced by colchicine. a-d, ramification of rhizoids. e, swelling of rhizoid. f, rhizoid formation from the rhizoidal protonema. g, ramification of rhizoidal protonema. h, ramified rhizoidal protonema and protonema appearing from the exine membrane.

II. The effects of colchicine

The author (4) described previously that the *Equisetum* spore cultured on a medium containing a large quantity of colchicine develops into a giant globe of about 10 to 15 times its normal volume, cell division being perfectly inhibited, and that cell-differentiation does not eventually occur. It is thus clear that colchicine acts not only as a polyploid inducer, but also as an effective modifier of rhizoid-differentiation and morphogenesis. In the case of *Dryopteris* spores, the rhizoids are always capable of differentiating, even in higher concentrations of colchicine. The rhizoidal protonema occurs in a higher frequency. The rhizoidal protonema is more lanky and longer containing less chloroplasts than normal protonema (5). This phenomenon was also observed in the medium containing tryptophane. Ramification of rhizoids is another effect of colchicine. Some photomicrographs (Fig. 4) show the germinating spores affected by colchicine. Figure 4a-d represent the typical ramification of rhizoids, 4e swelling rhizoid, 4f rhizoid formation of the rhizoidal protonema, 4g ramified rhizoidal protonema, and 4h the spore with a protonematic cell which emerges from the exine membrane and is exhibiting a characteristic state of ramified rhizoidal protonema. More detailed studies on the ramification of rhizoid induced by colchicine were reported previously (6).

Discussion

According to Bloch (1, 2), cell-differentiation is determined by two major ways; one of these is the ability of specific internal and external environmental conditions eliciting a particular path of differentiation from previously undifferentiated, totipotent cells. The other type of differentiation is determined at a given cell division and a new characteristic then persists through subsequent cell division without apparent dependence on a specific environment. An example of the latter type is found in the case of rhizoid formation in ferns. The differentiation of cells in the meristem of *Ricinus* into secretory idioblasts has been described by Bloch (2). The first division causes an undifferentiated cell to divide into two unlike daughters, the one containing a red pigment, tannin and unsaturated fats, and other lacking detectable amounts of these substances. The pigmented daughter cell produces also a row of pigmented cell; the colourless daughter cell gives rise to a row of cells, all of which are also pigmented. In ferns the daughter cell originating at the pole of the mother cell rich in protoplasm is characterized by its larger size and an increased power of differentiation, i.e., a capability of more active nuclear division.

Jacobs (3) reported that auxin controls the rhizoid formation in *Bryopsis*. The author obtained similar results in the germinating spore of *Equisetum* treated by IAA. In *Dryopteris*, IAA induces without exception the rhizoid to develop, causing it to swell. NAA inhibits frequently the rhizoid formation from the spore, but promotes the formation of lateral rhizoids. On the other hand, in *Osmunda* NAA prevents the rhizoid formation from both the spore and protonema. Therefore, the

action of auxin varies greatly according to the spore's condition in the different species and even in one and the same species used as an experimental material. General aspects of colchicine effect of fern prothallia are not touched in the present paper.

Summary

The effects of naphthalene acetic acid and colchicine on the rhizoid formation in *Dryopteris* spore were described. The results obtained are summarized as follows:

1. In contrast with the case of *Equisetum* spore, the formation of rhizoid is prevented greatly in the medium containing NAA. That is, NAA-treatment of the germinating spores prevents the formation of rhizoid from the spore, but rather promotes it from the protonema.

2. The position of the rhizoid initiation is very irregular in the spore cultured in the medium containing NAA.

3. The frequency of occurrence of the rhizoidal protonema is higher in the case of the colchicine treatment.

The author wishes to express his hearty thanks to Prof. T. Shimamura who kindly examined the manuscript of the present paper.

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Interaction of Temperature and Light in the Germination of *Nigella* Seeds I

by Sigeo ISIKAWA*

石川茂雄*: クロタネソウの種子の発芽におよぼす光と温度との関係 I

Received June 12, 1957

Introduction

Most of recent studies on light effects upon germination of seeds are those for light sensitive seeds. Especially, a recent brilliant achievement by Borthwick on seed germination of *Lactuca*¹⁾ and *Lepidium*⁶⁾, which are light seeds, indicates the identity of the mechanism of light response in several forms of plant development, e.g., seed germination, flowering reduction and de-etiolation.

There are not so many studies on seed germination of light inhibited seeds (dark seeds), especially on its mechanism of photoresponse. Meischke⁵⁾ studied on action spectrum of seed germination and recognized that seeds could be classified into light seeds and dark seeds according to the quantitative difference of two kinds of pigment, one of which absorbs inhibitory wave-lengths and the other, promotive wave-lengths. More recently, Bünning⁽²⁾ pointed out the presence of the effective intermediary dark period between two irradiation periods.

Jones and Bailey⁽⁴⁾ reported that *Lamium* was a kind of light inhibited seeds, and in them as in *Lepidium* seeds, there was photoreversibility of light response to red (promotive) and to far-red (inhibitive) radiation. They also reported that the germination of *Lamium* seeds was prevented by radiation of wave-length of 3600 Å.

The author of the present report studied on germination response of *Nigella* seeds, a typical dark seed, to light and temperature, and recognized that there were three separately acting factors in such response which affected germination of seeds. They were:

- (1) Inhibitory response to high intensity of light.
- (2) Promoting response to low intensity of light.
- (3) Response to high temperature.

Methods and Material

The method of seed treatments before and after irradiation and the methods of irradiation and alternation in temperature, employed in these experiments were

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much the same as those used in the experiments with *Epilobium*⁽³⁾.

0.7~0.8 % agar-solution was poured into the Petri dishes of 6.5 cm. diameter by some 10 c. c. each. On to the solidified surface, a little water was added, and 100 seeds were disseminated into each Petri dish, which was immediately covered with thick black paper and entered into a fixed-temperature cabinet. Temperature was usually controlled at 15°C except when it was changed specially at 0°C or 30°C under the experimental necessity, for 10°~15°C is most favorable for the germination of *Nigella* seeds.

Matsuda's incandescent-filament lamps of 20, 60, and 200 watt were used as radiation sources for the experiments at temperatures of 0°, 15°, and 30°C, respectively.

Experiments at 15° C were made in a room which was usually controlled at a constant temperature. Experiments at 30°C were performed in a radiation box maintained at a fixed temperature, and those at 0°C in an electrical refrigerator with a radiation equipment. Light intensity was altered by changing a distance from a light source to an irradiated Petri dish and measured by illuminometer to be fixed at a definite intensity.

The calculating method of germination rates in the present experiment was changed from the previous method the author used in *Nicotiana* and *Epilobium*, etc. In the present experiments, germinated seeds were counted on the ninth day from the dissemination (nine days' period is long enough to germinate) and the germination rates were calculated, while in all the previous experiments, germination counts were made on a certain days after the last irradiation, regardless of disseminating time. The obtained germination rates were compared with the rate in continuous dark at 15°C. If the result was higher, it was regarded as "promoted rate", and if lower, "inhibited rate". The average rate of three Petri dish belonging to the same experimental group was considered to be the germination rate of the group. The same experiment was made over again or several times, so as to make the results reliable.

These data were compiled from the results of about 200 experiments, which were made during the period from Nov., 1955 to Feb., 1957.

Employed seeds were planted in Nagano Pref. by Daiichi Engei Co., Ltd. of Shibuya, Tokyo, and they were harvested in Oct., 1955 and in the next year's late October.

Results

Time of inhibition till the first irradiation or till the temperature change was indicated by the number of hours and referred to as "Dp;—hrs", in the present report.

(1) Light-sensitivity curve:

Seeds subjected to Dp; 0, 6, 12, 24, 36, 48, 60, and 72 hrs each were exposed to

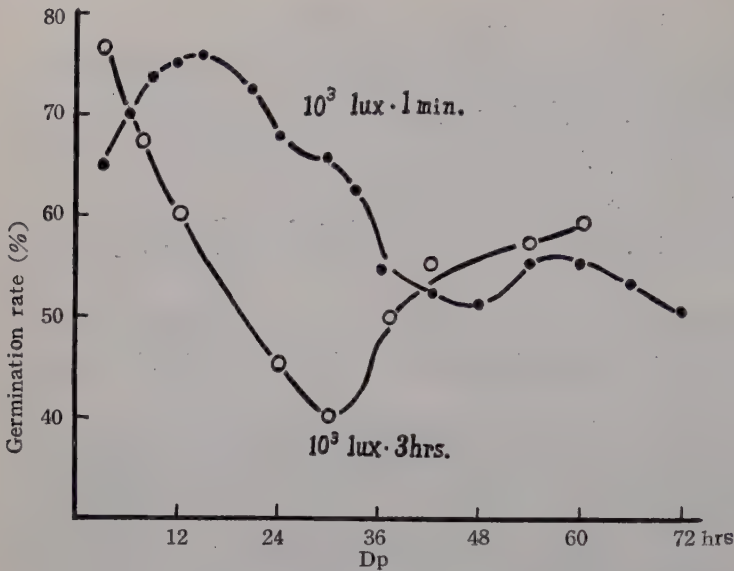


Fig. 1. Light-sensitivity curves, exposed to 10^3 lux for 1 min. and 3 hrs.

(i) In case *Nigella* seeds were exposed to very short time (1 min) irradiation, their germination rates were promoted in the region of Dp; 3 hrs to Dp; 72 hrs, a peak point having been marked at Dp; 18 hrs; in these cases, promoted rates were obtained, compared with the rate in continuous darkness (57%).

(ii) When, however, the same seeds were subjected to long time exposure to light for 3 hrs, the germination rates were inhibited progressively as the number of Dp; hrs advances, though it was promoted in Dp; 0~6 hrs. The inhibiting effect

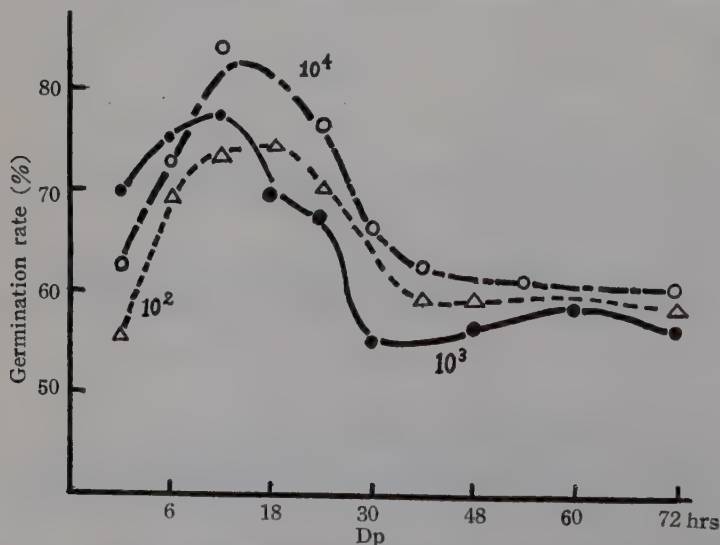


Fig. 2. Light-sensitivity curves taken by varied light intensities for 1 min.

the light intensity of 10^3 lux for very short time (1 min.), and the same were done for 3 hrs. The germination rates were counted for these two cases and they were plotted against Dp; -hrs.

These curves are referred to as "Light-sensitivity curve". These two curves shown in Fig. 1 suggest;

(i) In case *Nigella* seeds were exposed to very short time (1

min) irradiation, their germination rates were promoted in the region of Dp; 3 hrs to Dp; 72 hrs, a peak point having been marked at Dp; 18 hrs; in these cases, promoted rates were obtained, compared with the rate in continuous darkness (57%).

(ii) When, however, the same seeds were subjected to long time exposure to light for 3 hrs, the germination rates were inhibited progressively as the number of Dp; hrs advances, though it was promoted in Dp; 0~6 hrs. The inhibiting effect was marked most remarkably at Dp; 30~36 hrs, and this effect gradually lessened as the number of Dp; hrs increased until Dp; 72 hrs at which the same rate as that in continuous darkness was obtained.

(2) Promoting effect of short time irradiation:

The seeds were exposed to a very short time irradiation (for

1 min.) of 10, 10² 10³ and 10⁴ lux, respectively. The light sensitivity curves showed about the same tendency irrespective of light intensities. (See Fig. 2)

Then, the light-sensitivity curve of 10³ lux 1 min. irradiation at 0°C was compared with the curve at 15°C under the same intensity of irradiation. The 1 min. irradiation at 0°C was specially performed just in the middle of the one hour period at 0°C. As illustrated in Fig. 3, these two curves moved in almost the same way. Furthermore, it was observed that the germination rate of the seeds held for one hour at 0°C after each Dp; hrs was not at all different from the rates of seeds placed in continuous darkness at 15°C.

(3) Inhibitory effect of long time irradiation:

Inhibitory trend

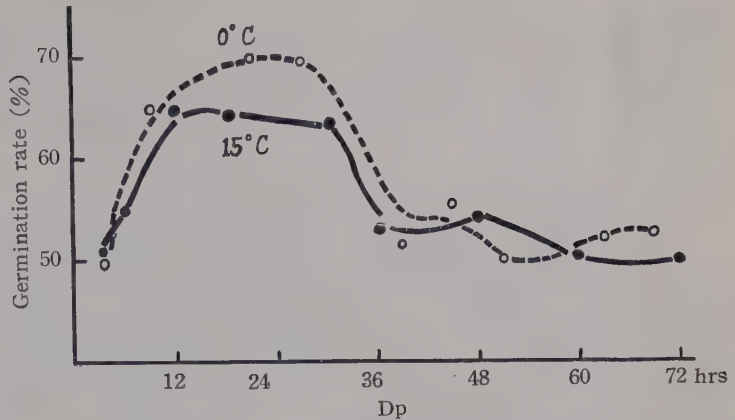


Fig. 3. Light-sensitivity curves of 10³ lux·1 min. irradiation at 0°C and 15°C.

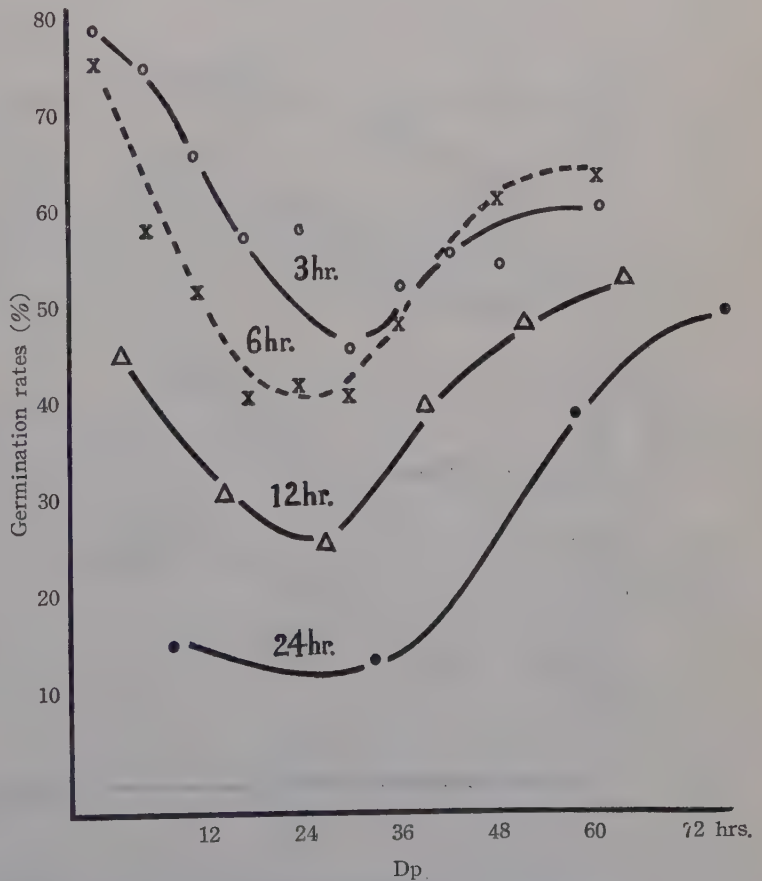


Fig. 4. Light-sensitivity curves, exposed to 10³ lux for 3, 6, 12 and 24 hrs.

increased with lengthening of irradiating period, if light intensity was not changed at 10^3 lux, as shown in Fig. 4. (24 hrs irradiated most sufficiently). And in any irradiating time, the lowest germination was obtained with Dp; 30~36 hrs. Next, irradiating time was fixed at 12 hrs and light intensity was varied. In this case, the higher intensity was given, the larger inhibitive trend appeared.

(4) Influence of high temperature (30°C):

The germination rates of seeds placed in continuous darkness on beds which were maintained at 20° , 25° and 30°C were 38, 19, and 0 % respectively. But, as period at 30°C was shorten, inhibitory degree was reduced. When germination beds were placed at 30°C for 3 to 6 hours, germination was prevented to a certain degree if seeds were subjected to Dp; 0~24 hrs, but with Dp; 24~72 hrs, germination was promoted to some extent.

Generally, with small numbers of Dp; hrs, high temperature suppressed germination, with Dp; 36~60 hrs, it promoted, and with Dp; 72 hrs and over, influence of high temperature was not seen. (See Fig. 5)

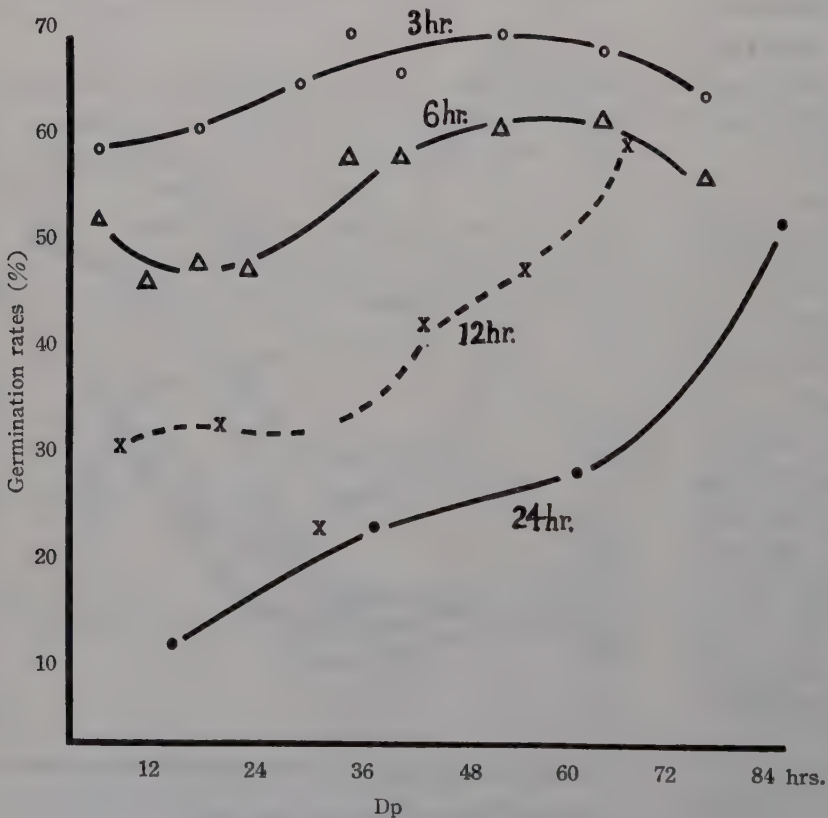


Fig. 5. Germination rates of seeds placed at 30°C for 3, 6, 12 and 24 hrs.

(5) Combination of short time irradiation and high temperature:

When short-time irradiation (10^3 lux \cdot 1 min.) was given to the seeds in the middle of the period placing at high temperature ($30^\circ\text{C} \times 6$ hrs), the highest germination rate was attained. (See Fig. 6)

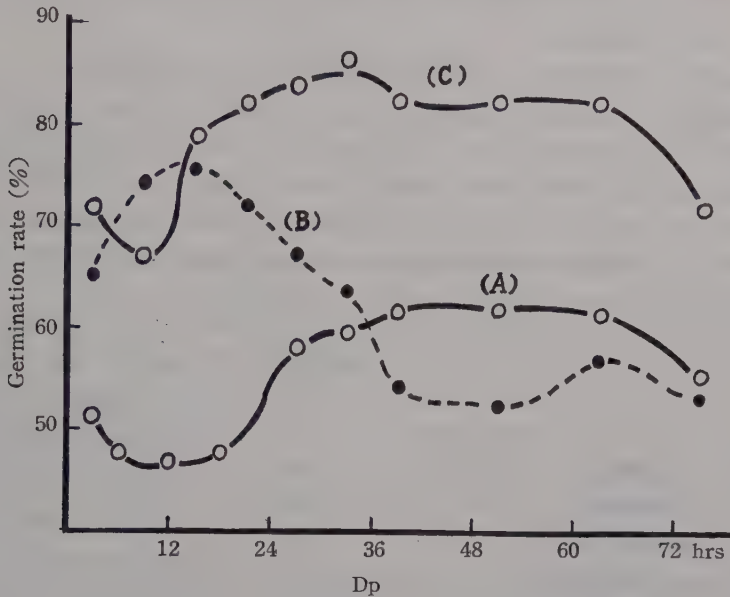


Fig. 6. (A) Germination rates obtained by the temperature change (30°C , 6 hrs); (B) light-sensitivity curve of 10^3 lux \cdot 1 min., irradiation only; (C) light-sensitivity curve of 10^3 lux \cdot 1 min., irradiation given in the middle of high-temperature (at 30°C for 6 hrs).

The germination rate for each Dp; hrs of the seeds held at high temperature and exposed to short time irradiation is nearly equal to the sum of the germination rate obtained by the temperature change in the respective Dp; hrs and the enhancement by the short time irradiation in Dp; 18 hrs.

Next, the two germination promoting effect, i.e., short time irradiation (1 min.) and high temperature (3~6 hrs) treatment, were given separately. In this case, two different results were obtained according to the time of high temperature treatment.

In case high temperature was given within 24 hrs from presoaking, the light-sensitivity curve from short time irradiation was formed in the lower side of and in parallel with the curve formed by the irradiation alone. The margin of the two curves means the prevention by high temperature.

But, when the seeds which were presoaked for 30 hrs and over were laid at high temperature and irradiation was made prior to high temperature treatment, the highest germination rates were obtained in all cases. In the case of the seeds subjected to Dp; 30 hrs and over, short time irradiation gave no promoting effect

on germination, nevertheless, if those seeds were laid in high temperature after the irradiation, the highest germination rate was obtained. This rate is the sum of the maximum light sensitivity and promotive effect by the temperature change. However, when the irradiation was made after the high temperature treatment, prohibitory effect of irradiation was not observed, and a favourable effect of temperature change was recognized.

(6) Long time irradiation during the period at high temperature:

When long time irradiation and high temperature treatment were performed separately, strong prohibitory effect was produced in each case. This suggested that much higher prohibitive effect could develop if the above mentioned two prohibitive treatments were taken place at a time. Contrary to this expectation, however, long time irradiation during the period at high temperature proved to be less prohibitive than each of the above treatment performed separately.

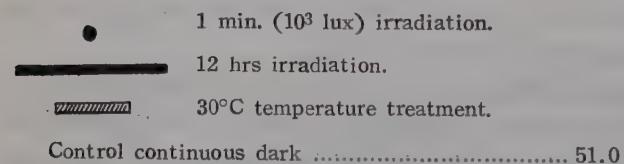
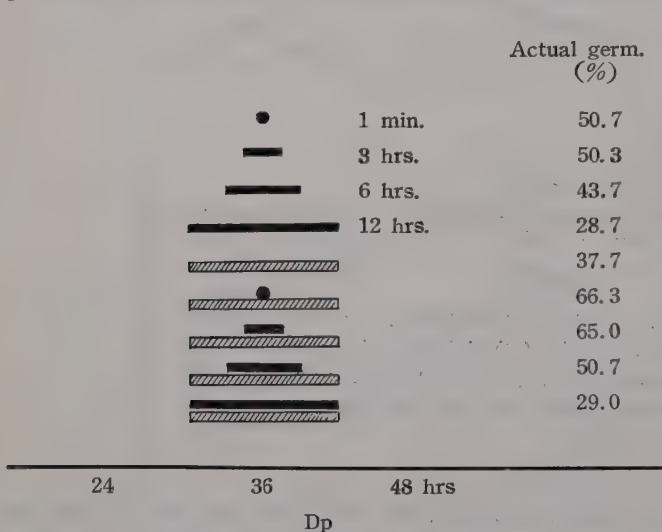


Diagram 1. Germination rates of seeds exposed to irradiation at 30°C.

This is explained as below. The germination rate obtained from long time irradiation performed together with high temperature treatment is about the same as the rate at continuous darkness minus inhibitory rates, resulting separately from high temperature treatments and from irradiation, plus promotive rate by weak of high temperature. (See Diagram 1). In other words, the germination rate resulting from long time irradiation at high temperature is considered to be an all-round result of responses to each separate treatment, namely,

inhibitory response to long time irradiation, temperature response (also inhibitory), and promotive response to short time irradiation.

To sum up, each of these three factors (inhibitory effect of long time irradiation—high intensity process, promotive effect of short time irradiation—low intensity process, and effect of high temperature) exists and acts individually of others.

Interaction of Temperature and Light in the Germination of *Nigella* Seeds II

by Sigeo ISIKAWA*

石川茂雄*: クロタネソウの種子の発芽におよぼす光と温度との関係 II

Received June 12, 1957

(7) Individuality or three processes

To assure this, the following experiments were performed.

- (a) Combination of long time, high temperature treatment (inhibitory effect) and short time irradiation during the period placing at high temperature (promotive effect): (See Diagram 2-A)

The theoretical germination rate is calculated from the rate in continuous darkness (51%), deducted inhibitory rate (−31%) and added promotive rate (+19%). And you can see the calculated figure (39%) was much the same as the actual figure (45%).

- (b) Combination of long time irradiation having inhibitory effect and weak irradiation under high temperature (this has promotive effect); (See Diagram 2-B)

In this case, actual rate figure, 42% was approximately the same as the calculated or theoretical figure 44%.

The short time promotive irradiation was performed in two different ways this time, i. e., before and after the long time inhibitive irradiation, and in both cases, much the same results were obtained.

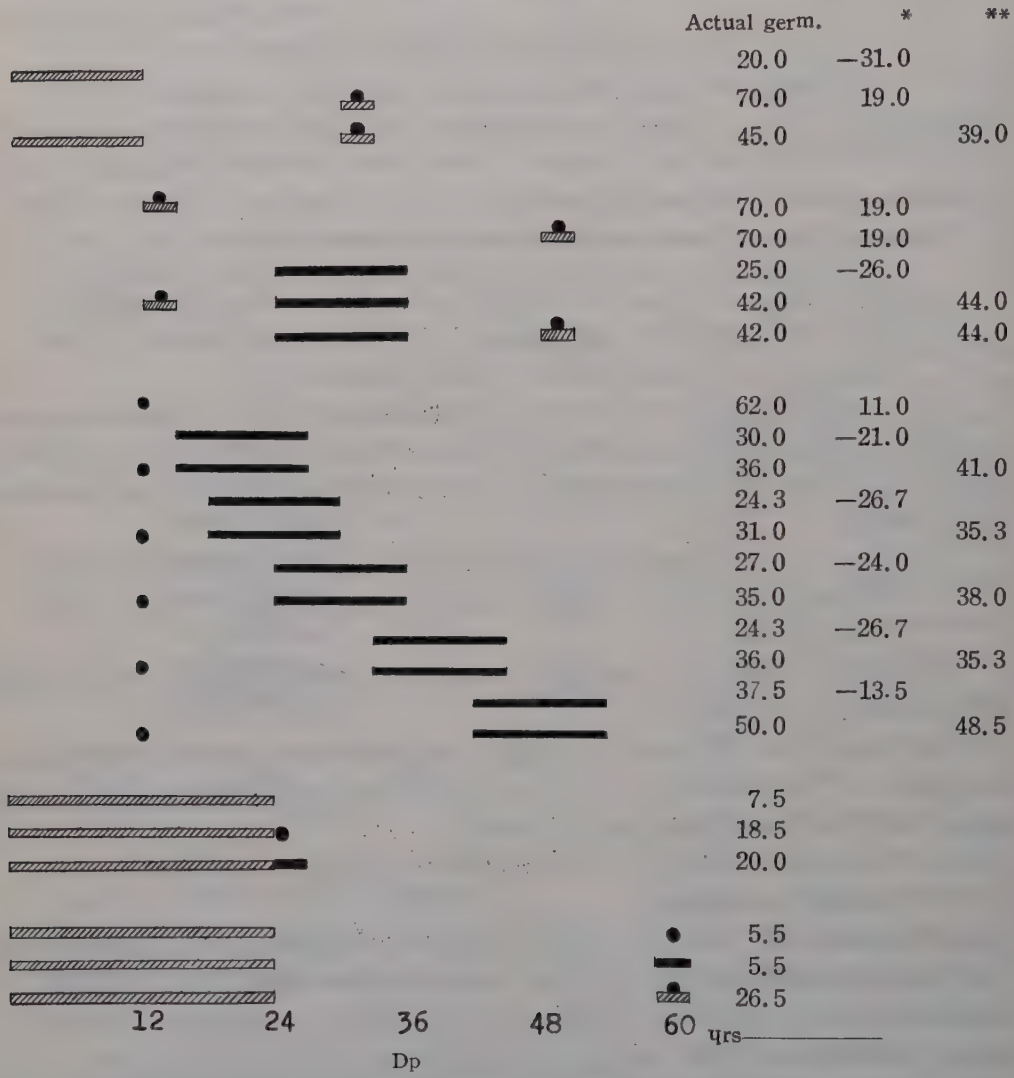
- (c) Combination of short time promotive irradiation and long time inhibitory irradiation:

In Diagram 2-C, it can be clearly seen that promotive effect of short time irradiation and inhibitive effect of long time irradiation exist and act separately even in the case when these two kinds of irradiation were made at interval of three hours between them, and this is quite the same at interval of 30 hrs.

- (d) In case 10^3 lux•24hrs irradiation was given immediately after the presoaking, very strong inhibition approximating to so-called "Lichthart" was observed. But, when temperature of 30°C for 6 hrs was given, 20% increase of rate was obtained. This increase may be regarded as promotive rate by high temperature response after short time irradiation.

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Next, in case seeds were being placed at 30°C for 24 hrs, germination was almost completely hindered. But, if short time irradiation was given immediately after the period at 30°C or if short time irradiation at high temperature was supplied after some time from the first period at high temperature (30°C), the germination rate showed an increase of 10~20%. (See Diagram 2-D).



* Degree of inhibition or promotion. ** Theoretical germination rate (%).
Diagram 2. Germination rates of two times treatments.

All these experiments show the fact that irradiation and high temperature give their individual effect on germination in different ways.

(e) In case long time irradiation was given at 0°C, inhibitory effect of strong irradiation stopped, and promotion by weak irradiation appeared regardless of temperature. (See Diagram 3).

This suggests that during long time irradiation, response to low intensity of light was acting simultaneously with the effect of long time irradiation.

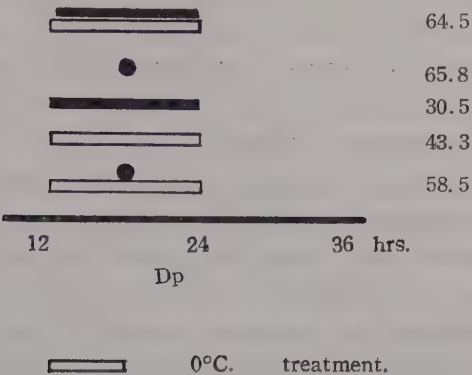


Diagram 3. Germination rates of seeds exposed to irradiation at 0° C

(8) Action spectrum

Influence of wave length on germination varies according to duration of inhibition time.

(A) With Dp; 18 hrs: Red radiation (6400 Å) for $\frac{1}{60}$ to 6 hrs resulted in promotion of germination. Short time exposure to light of wave-length between 4300 to 5400 Å scarcely had an effect on germination, whereas exposure for 6 hrs to these wave-lengths stimulated the germination. In short, these wave-lengths and less promotive effect on germination than red. Far-red irradiation for $\frac{1}{60}$ to 6 hrs. had little effect. To sum up, only promoted effect could be seen in the case of Dp; 18 hrs and under.

(B) With Dp; 30 hrs: Exposure to red radiation for $\frac{1}{6}$ to 3 hrs enhanced germination, but longer exposure reduced the promoting effect and the germination rates approached the rate in continuous dark. Exposure to radiant energy in the region of 4300 to 5400 Å for short time (3~12 hrs) had no effect, but longer radiation had promotive effect. Far-red irradiation for long time had an inhibitory effect. Therefore, germination limitation by long time exposure to light from an incandescent lamp could be identified with an inhibitory effect of far-red radiant energy.

(C) Reversible relation between red energy and infrared energy could not be seen.

Discussion

Light sensitivity curve formed by short time irradiation showed maximum point at Dp; 18 hrs (under 15°C). Under 100~10000 lux•1 min. light quantity, about the same result was obtained. And, this movement of curve did not change in an irradiation under 0°C. From these results, the enhancement of germination by short time irradiation can be considered a pure photochemical reaction to low light in-

tensity. This weak light reaction did not need an effect of separate twice irradiation, i.e., an existence of an effective dark period between two light periods.

Then, the optimum germination rate was obtained by placing seeds at high temperature immediately after exposure to weak (short time) irradiation. This led to a further assumption of existence of a labile fraction in the series of a photochemical response, which resulted in the enhancement of germination by high temperature. This has already been observed by Borthwick in *Lepidium*,

Quite regardless of this promotive response to weak light or far-red radiant energy, there is an inhibitory response to long time exposure to strong irradiation. This inhibitory response showed its maximum around Dp; 30 hrs, which was 12 hours later than the optimum point of weak light response. This inhibitive effect could not be observed with an irradiation at 0°C. Therefore, it could be guessed that this responsive series was not a mere photochemical reaction but a more complicated series of enzymatic reaction.

It could be cleared that a germination rate resulting from irradiation for long time at high temperature is a total sum of three separate factors, i.e., inhibited rates by long time irradiation and by placing at high temperature and a promoted rate by weak irradiation at high temperature.

Furthermore, three combination tests were performed, i.e., strong irradiation and weak irradiation; high temperature and weak irradiation; high temperature and strong irradiation. All the results proved the about assumption to be true.

Reversible relation between promotive red and inhibitive far-red radiant energy, which was observed by Borthwick in *Lepidium* and by Jones and Bailey in *Lamium*, could not be recognised by the author in *Nigella* both in weak light response and in strong light response.

As for effectiveness of intermediary dark period between two inhibitory irradiations reported by Bünning⁽²⁾, no affirmative result was obtained by the author.

Summary

Interaction of light and temperature in germination of *Nigella*, typical light inhibited seeds, was investigated according to variation of presoaking time represented by number of Dp; hours. And the following results were obtained.

1. It was confirmed that germination promoting response to weak light and inhibiting response to strong light, exist individually.

2. Seed's response to weak promotive light at 15°C marked maximum sensitivity at Dp; 18 hrs. This is a pure photochemical reaction to weak light (6×10^3 MKS), in which there is a fraction acting more promotively by high temperature after irradiation.

3. No reversible relation between red and far-red was observed in *Nigella*'s weak-light response, though it was proved by Brothwick in *Lepidium* and considered to be a general nature of weak light response.

4. Inhibitive response to long time irradiation, which appears most remarkably at DP; 30 hrs meant inhibitory response to far-red radiant energy. This inhibitory effect becomes null at 0°C. Then, this has not been regarded as a mere photochemical reaction but a more complicated enzymatic reaction.

5. Response to high temperature also exists separately from light response. It prevented germination strongly in earlier Dp; hrs. But, in Dp; 24~60 hrs, comparatively short time (3~6 hrs) exposure to high temperature brought about 10 % increase of germination rate.

6. The germination rate obtained from simultaneously exposure to light and high temperature, was equal to a total sum rate of (1) effect of high temperature (temperature reaction), (2) inhibited rate of inhibitory response to long time irradiation, and (3) promoted rate by exposure to weak light (short time radiation) at high temperature, added to (4) the germination rate in continuous darkness.

7. It has been clarified that each of three factors (weak-light response, strong light response and temperature response) exists separately from the other two factors.

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Notes on *Cephaleuros* and *Phycopeltis*, Parasitic and Epiphytic Aerial-Algae III. Lists of Infected Plants

by Sirô SUÉMATU*

末松四郎*: 地上藻類 *Cephaleuros*, *Phycopeltis* について III. 寄着植物表

Received June 28, 1957

Some algae of Trentepohliaceae, a family of aeriæ Chlorophyte, are terrestrial, endophytic or epiphytic. The characteristic orange-red color of this family is due to the usual presence of haematochrome dissolved in fat which is found in cells.

According to the study of G. Karsten (1891) who worked out entirely on the group in early time, four genera viz. *Trentepohlia*, *Chroolepus*, *Cephaleuros* and *Phycopeltis* are included in the Trentepohlieae (Chroolepida), the latter two genera being found always on leaves of phanerophyte all through the year.

Cephaleuros virescens is parasitic and found usually on the upper surface of leaves occasionally on the lower surface, and seldom on the stem and fruits. The thallus of the alga is discoid and crusty, and arises from radially several creeping threads which grow fuse and form a compact basal layer, between the cuticle and the epidermal cells of a leaf. *Phycopeltis epiphyton* is a small discoid epiphyte, forming a compact one-layered substratum on the upper surface of a leaf and is always extracuticular.

There were some confusions as to the scientific names for the algae in early time. The specific name of *Cephaleuros virescens* was given by Kunze in 1829, but *Mycoidea parasitica* D. D. Cunningham (1880) and *Cephaleuros mycoidea* G. Karsten (1891) were used until Cunningham recognized again the Kunze's name in 1897. *Phycopeltis epiphyton* was erected in 1870 by A. Millardet. But the alga was also called synonymously *Phyllactidium arundenaceum* F. T. Kützinger (1849) or *Phyllactidium tropicum* M. Möbius (1888) until A. V. Jennings revised the genus in 1896.

In India, *Cephaleuros* is known to cause a serious damage, the so-called Red Rust, of tea plants. H. H. Mann and C. M. Hutchinson (1907) said that *Cephaleuros* began to attract attention since about 1880 as a causer of "White Blight", a disadvantageous disease of tea and other useful tropical plants. Heretofore, no one denoted an evident damage of useful plants by epiphytic *Phycopeltis*, but it seems that the alga prevents the green plants from sound assimilation because small specks of *Phycopeltis* cover the surface of leaves and hinder direct sun-shine.

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In countries especially in tropical or subtropical regions, as India, Ceylon, Java, Brasil and also Florida (U. S. A.) these algae are widely known. And many investigators wrote reports on the subjects of life-history, distribution, damages on useful plants and practical methods of prevention, of the algae, and lists of infected plants by the algae.

In Japan, the algae is also distributed very widely, however they were remained almost untouched. Merely in some practical books of tea we found descriptions of at most a few lines on "Siromo-byo", the disease of tea plants caused by *Cephaleuros*. In 1926, Hans Molisch reported botanically for the first time on these algae in Japan with a list of infected plants. After that, the writer noted some additional list of such plants preliminarily in 1950.

In this paper, the writer wishes to list all hitherto known infected plants by the algae, adding newly found species since 1950 from Japan by him.

List of plants infected by *Cephaleuros virescens*

Name	Locality	Observer
Pteridophyta	India	Cunningham, D. D. 1880**
<i>Cyclophorus lingua</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Polypodium hastatum</i>	Japan (Honsyu)	Suématu, S. 1950
Gymnospermae		
<i>Torreya nucifera</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Podocarpus chinensis</i>	Japan (Honsyu)	Suématu, S. 1950
Angiospermae		
<i>Pandanus</i> sp.	India (North-eastern dist.)	Karsten, G. 1891**
<i>Calathea metallica</i>	India (North-eastern dist.)	Karsten, G. 1891**
<i>Piper Futokadzura</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Myrica rubra</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Quercus phylliraeoides</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Q. gilva</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Q. glauca</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Q. myrsinaefolia</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>Pasania cuspidata</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Shiia Sieboldii</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Celtis sinensis</i> var. <i>japonica</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Ficus nipponica</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>F. erecta</i>	Japan (Honsyu)	Suématu, S.*
<i>F. Wightiana</i>	Japan (Honsyu)	Suématu, S.*
<i>Helicia cochinchinensis</i>	Japan (Honsyu)	Suématu, S.*

<i>Akebia trifoliata</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Stauntonia hexaphylla</i>	Japan (Honsyu)	Suématu, S.*
<i>Menispermum dauricum</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Magnolia grandiflora</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>Illicium religiosum</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Kadsura japonica</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Cinnamomum japonicum</i>	Japan (Honsyu)	Suématu, S. 1950
<i>C. Camphora</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>C. iners.</i>	India	Cunningham, D. D. 1887**
" "	India (North-eastern dist.)	Mann, H. H. & Hutchinson, C. M. 1907
<i>Litsea glauca</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Machilus Thunbergii</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Actinodaphne acuminata</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Distylium racemosum</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Photinia glabra</i>	Japan (Honsyu)	Suématu, S.*
<i>Albizia stipulata</i>	India (North-eastern dist.)	Mann, H. H. & Hutchinson, C. M. 1907
<i>Tephrosia candida</i>	India (North-eastern dist.)	Molisch, H. 1926
<i>Citrus</i> sp.	Florida (U. S. A.)	Wolf, F. A. 1930 (cf. Fritsch 1935)
" "	Florida (U. S. A.)	Suit, R. F. 1949***
" "	Florida (U. S. A.)	Knorr, L. C. 1950***
<i>Croton</i> sp.	India	Cunningham, D. D. 1880**
<i>Rhus silvestris</i>	Japan (Honsyu)	Suématu, S.*
<i>Mangifera indica</i>	India	Cunningham, D. D. 1880**
" "	India (North-eastern dist.)	Butler, E. J. 1906**
" "	India (Central-southern dist.)	Safeeulla, K. M. & Govindu, H. C. 1948***
" "	Ceylon	Ward, H. M. 1884**
<i>Ilex Oldhami</i>	Japan (Honsyu)	Suématu, S.*
<i>I. latifolia</i>	Japan (Honsyu)	Suématu, S.*
<i>I. rotunda</i>	Japan (Honsyu)	Suématu, S.*
<i>I. integra</i>	Japan (Honsyu)	Suématu, S.*
<i>Turpinia pomifera</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Zizyphus jujuba</i>	India (North-eastern dist.)	Karsten, G. 1891**
<i>Thea sinensis</i>	Ceylon	Ward, H. M. 1884**
" "	India	Cunningham, D. D.** 1880, 1887, 1897.
" "	India (North-eastern dist.)	Mann, H. H. & Hutchinson, C. M. 1907
" "	India (Central-southern dist.)	Safeeulla, K. M. & Govindu, H. C. 1948***
" "	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950

<i>Cleyera ochracea</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>Eurya japonica</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>Camellia japonica</i>	India	Cunningham, D. D. 1887**
" "	India (North-eastern dist.)	Mann, H. H. & Hutchinson, C. M. 1907
" "	India (Central-southern dist.)	Safeeulla, K. M. & Govindu, H. C. 1948***
" "	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>C. sasanqua</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Ternstroemia japonica</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Xylosma Apactis</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Daphne kiusiana</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Meliosma rigida</i>	Japan (Honsyu)	Suématu, S.*
<i>Psidium Guayava</i>	India (North-eastern dist.)	Yadva, A. S. 1952***
<i>Jambosa vulgaris</i>	India (Central-southern dist.)	Safeeulla, K. M. & Govindu, H. C. 1948***
<i>Schefflera octophylla</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Aucuba japonica</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Rhododendron</i> sp.	India	Cunningham, D. D. 1880**
" "	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Enkianthus perulatus</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Rapanaea neriifolia</i>	Japan (Honsyu)	Suématu, S.*
<i>Symplocos glauca</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Osmanthus ilicifolius</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Ligustrum medium</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Limnanthemum indicum</i>	India	Cunningham, D. D. 1887**
<i>Trachelospermum asiaticum</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Anodendron affine</i>	Japan (Honsyu)	Suématu, S.*
<i>Coffea liverica</i>	Ceylon	Ward, H. M. 1884**
<i>Viburnum odoratissimum</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>V. dilatatum</i>	Japan (Honsyu)	Suématu, S. 1950

Notes: * Species newly found since 1950.

** cf. H. H. Mann and Hutchinson C. M. 1907.

*** cf. Biological Abstracts.

List of plants infected by *Phycopeltis epiphyton*

Name	Locality	Observer
Bryophyta		
<i>Leskea</i>	Europe	Molisch, H. 1926
<i>Rhizogonium Dazy anum</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
Pteridophyta		
<i>Lycopodium serratum</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Drymoglossum microphyllum</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Polypodium falcatum</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Lomaria nipponica</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
Gymnospermae		
<i>Torreya nucifera</i>	Japan (Honsyu)	Suématu, S.*
<i>Cephalotaxus drupacea</i>	Japan (Honsyu)	Suématu, S.*
<i>Abies firma</i>	Japan (Honsyu)	Suématu, S.*
<i>A. sp.</i>	Europe	Molisch, H. 1926
<i>A. sp.</i>	Europe	Fritsch, F. E. 1935
<i>Cryptomeria japonica</i>	Japan (Honsyu)	Suématu, S.*
<i>Chamaecyparis obtusa</i>	Japan (Honsyu)	Suématu S.*
Angiospermae		
<i>Saccolabium Matsuran</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Sarcochilus japonicus</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Piper Futokadzura</i>	Japan (Honsyu)	Suématu, S.*
<i>Pasania sp.</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Ficus nipponica</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Litsea japonica</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Rubus sp.</i>	Europe (North dist.)	Molisch, H. 1926
" "	Europe	Fritsch, F. E. 1935
<i>Ilex integra</i>	Japan (Honsyu)	Suématu, S.*
<i>I. latifolia</i>	Japan (Honsyu)	Suématu, S.*
<i>Camellia japonica</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
" "	Japan (Honsyu)	Suématu, S. 1950
<i>Cleyera ochracea</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Eurya japonica</i>	Japan (Honsyu)	Suématu, S.*
<i>Elaeagnus pungens</i>	Japan (Honsyu)	Suématu, S.*
<i>Hedera sp.</i>	Europe	Fritsch, F. E. 1935
<i>Aucuba japonica</i>	Japan (Honsyu, Kiusyu)	Molisch, H. 1926
<i>Maesa japonica</i>	Japan (Honsyu)	Suématu, S.*
<i>Trachelospermum asiaticum</i>	Japan (Honsyu)	Suématu, S. 1950
<i>Callicarpa japonica</i>	Japan (Honsyu)	Suématu, S.*

Note: * Species newly found since 1950

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75周年記念

(第22回)

日本植物学会大会

プログラム

1957

会期 10月12日(土)——15日(火)

会場 東京大学教養学部(東京都目黒区駒場町)

大会会長 小倉 謙

学会会長 服部 静夫

日程

	午前	昼	午後	夜
12日(土)	一般講演		一般講演 シンポジウム(1,2)	日本藻類学会 第5回総会
13日(日)	一般講演		特別講演 シンポジウム(3,4)	植物分類学会 生理談話会
14日(月)	一般講演		記念写真, 総会, 記念式, 記念講演	懇親会
15日(火)	一般講演		都内見学	大島旅行(10時)
	9.00	12.00	1.00 3.00	5.00

評議員会 10月11日(金)午後5時から
本郷 学士会館別館

懇親会 10月14日(月)午後6時から
神田一ツ橋 学士会館

一 般 講 演

[A 会 場]

細 胞

9.00—9.13 (A 1)	フォイルゲン染色による酵母核の研究	東大・理	米 田 芳 秋
9.15—9.28 (A 2)	アカパンカビ雌雄接合型にみられた被子器形成に対する NH_4 態および NO_3 態窒素源の有効性のちがい	帯広畜産大	伊 藤 太 郎
9.30—9.43 (A 3)	カルス形成の際におけるフェノール酸化酵素の活性度の変化	京大・理	馬 場 三 吾
9.45—9.58 (A 4)	アカウキクサの根毛内の顆粒について	愛知学芸大	川 松 重 信
10.00—10.13 (A 5)	発芽にともなう TTC 還元様式の変化と細胞構造との関係	東大・理	佐 藤 七 郎
10.15—10.28 (A 6)	クロマツの胚発生の組織化学的研究	名大・理	高 尾 昭 夫
10.30—10.43 (A 7)	数種の沈水植物細胞における硝酸銀還元反応の検討	新潟大・理	吉 田 吉 男
10.45—10.58 (A 8)	組織化学における微量定量法	[農 技 研 "]	相 見 靈 三 子 磯 木 琉 璃 子
11.00—11.13 (A 9)	ムラサキツユクサの花粉粒有糸分裂の生体観察	宇都宮大・学芸	沢 村 正 五
11.15—11.28 (A10)	固定像における紡錘体の界面膜	[東大・理 "]	*和 田 文 吾 子 山 本 道 子
11.30—11.43 (A11)	<i>Crinum latifolium</i> および <i>Lycoris sanguinea</i> の雄性配偶体の発生について	お茶の水大・理	保 井 コ ノ

< 綜 合 討 論 >

[B 会 場]

分 類

9.00—9.13 (B 1)	放線菌の1新種 " <i>Streptomyces spiroverticillatus</i> nov. sp." について	大阪学芸大 平野分校	信 夫 隆 治
9.15—9.28 (B 2)	有柄細菌 <i>Caulobacter</i> に関する研究 (第2報)		増 田 染 一 郎
9.30—9.43 (B 3)	<i>Candelabrum</i> 属の観察	長 尾 研	椿 啓 介
9.45—9.58 (B 4)	口腔中より分離された酵母菌について	長 尾 研	曾 根 田 正 巳
10.00—10.13 (B 5)	日本およびその近接地域におけるカサゴケ科の研究 (第11報) <i>Bryum tortifolium</i> Funck とその近縁種について	鳥取大・学芸	越 智 春 美
10.15—10.28 (B 6)	南アルプスおよび秩父面石灰岩地域のセン類フロラの類似性	[名大・教養 秩 父 博]	*高 木 典 雄 巖 永 野
10.30—10.43 (B 7)	日本産キヌタゴケ属 (<i>Homomallium</i>) の分類と生態	広島大・理	安 藤 久 次
10.45—10.58 (B 8)	本邦産スギバミズゴケ類について	広島大・理	鈴 木 兵 二
11.00—11.13 (B 9)	シダ胞子の発芽能力	成城学園	川 崎 次 男
11.15—11.28 (B10)	前葉体によるウラボシ科の解釈とその類縁	文 部 省	百 瀬 静 男
11.30—11.43 (B11)	タヌキモ科植物に見られる発条形式と器官形成について	日本歯大	小 宮 定 志

< 綜 合 討 論 >

[C 会 場]

生 理

9.00— 9.13 (C 1)	暗所におけるユーグレナの炭酸固定について	東大・理	河 野 晴 也
9.15— 9.28 (C 2)	反応速度論的方法による光合成機作の研究	{東大・応微研 東大・理 東大・応微研	*宮 地 重 遠 広 田 川 康 田 宮 豊 博
9.30— 9.43 (C 3)	緑葉の光電反応(第1報) 明・暗期の長さによる反応の変化	東北大・農研	西 崎 友 一 郎
9.45— 9.58 (C 4)	暗期反応に対する高温と光の効果	{宮崎大・学芸 " "	*中 山 至 大 飛 田 博 温 中 村 国 治 子
10.00—10.13 (C 5)	イネ鞘葉切片の低酸素分圧における生長	東北大・理	大 脇 頼 子
10.15—10.28 (C 6)	ミトリササゲ幼生の生長に及ぼす赤色光の影響	名大・理	藤 井 良 平
10.30—10.43 (C 7)	短日効果と培養液中の鉄濃度との関係	{信州大・文理 " "	柴 田 治 *木 下 哲 雄
10.45—10.58 (C 8)	生長調節物質試験法(<i>Avena</i> 切片法)の一変法	東北大・理	長 尾 昌 之
11.00—11.13 (C 9)	オーキシン作用の原形質学的研究(第2報)	愛媛大・文理	増 田 芳 雄
11.15—11.28 (C10)	マカラスムギ子葉鞘の炭酸ガス固定とこれに及ぼすインドール酢酸の影響	東大・教養	八 巻 敏 雄
11.30—11.43 (C11)	低濃度のインドール酢酸による子葉鞘切片伸長の阻害	農 技 研	村 上 浩

< 綜 合 討 論 >

[D 会 場]

生 理

9.00— 9.13 (D 1)	藍菌の色および薬物耐性変異をもちいた二三の実験	和歌山大・学芸	香 山 時 彦
9.15— 9.28 (D 2)	食塩耐性酵母菌のナトリウムの結合について	{大阪市大・理工 " "	*高 田 英 夫 徳 野 真 一
9.30— 9.43 (D 3)	酵母変異菌のイオン交換性(第3報)	大阪市大・理工	平 岡 純 一
9.45— 9.58 (D 4)	銅耐性酵母の集団組成の変化	{京大・理 " "	*持 塚 洵 声 田 讓 治
10.00—10.13 (D 5)	酵母菌の W 変異と銅適応	大阪市大・理工	柳 島 直 彦
10.15—10.28 (D 6)	酵母の高濃度銅耐性	{京大・理 " "	*志 村 令 郎 芦 田 讓 治
10.30—10.43 (D 7)	含銅培地における酵母の銅吸着と耐性の関係について	甲南大・理	荒 勝 豊
10.45—10.58 (D 8)	酵母の銅耐性におけるいおうの意義	{京大・理 " "	*中 村 運 芦 田 讓 治
11.00—11.13 (D 9)	銅耐性酵母の硫化水素発生	{京大・理 " " " "	*内 貴 信 夫 菊 池 忠 寿 声 田 讓 治 地 貴 忠 夫 芦 田 讓 治
11.15—11.28 (D10)	銅耐性酵母の亜硫酸還元	{京大・理 " " " "	*菊 池 忠 夫 内 貴 忠 夫 声 田 讓 治 地 貴 忠 夫 芦 田 讓 治

< 綜 合 討 論 >

[A 会 場]

細 胞

13.00—13.13 (A12)	ヒロハアマナの胚嚢および胚乳について	三重大・学芸	及 川 公 平
13.15—13.28 (A13)	異質細胞質による異常気孔について	神戸大・理	深 沢 広 祐
13.30—13.43 (A14)	シダ類造精器における吸水力と透過性	山形大・教育	伊 倉 伊 三 美
13.45—13.58 (A15)	寄生性藻類による宿主植物組織の変化	和歌山大・学芸	末 松 四 郎
14.00—14.13 (A16)	フィリヤブランの色素体について	{東京教育大・理 " "	植 田 利 喜 造 *村 上
14.15—14.28 (A17)	<i>Trachelomonas</i> の細胞の電子顕微鏡的構造	京大・理	植 田 勝 巳
14.30—14.43 (A18)	ラン藻細胞の endoplasmic reticulum	{京大・理 " "	*新 家 浪 雄 植 田 勝 巳

< 綜 合 討 論 >

[B 会 場]

植 物 地 理

13.00—13.13 (B12)	秩父地方の石灰岩地の植物 (第1報)	秩父・尾田蒔中	守 屋 忠 之
13.15—13.28 (B13)	本土におけるヤチダモとシオジの天然分布	林 試	林 弥 栄
13.30—13.43 (B14)	日本海諸島の植物分布の概況 (その 2)	北海道学芸大 函館分校	菅 原 繁 蔵
13.45—13.58 (B15)	九州にあらたに発見されたソハヤキ分布 のツツジ属植物について	大分学芸大	鈴 木 時 夫
14.00—14.13 (B16)	本邦における暖帯着生植物	広島大・理	堀 川 芳 雄
14.15—14.28 (B17)	ミツガシワの遺体種子の計測による年代推定	大阪市大・理工	粉 川 昭 平
14.30—14.43 (B18)	遺体からみた邦産マツ科植物について	大阪市大・理工	三 木 茂

< 綜 合 討 論 >

シンポジウム (1, 2) 12 日 15.00—17.00 [C 会 場]

1. 小 胞 子 の 発 生 と 類 型	15.00—16.00		
a. 水生植物の花粉形態		話題提供者	原 田 市 太 郎
b. 針葉樹の花粉形態		話題提供者	上 野 実 朗
2. 花 の 形 成 の 諸 問 題	16.00—17.00		
a. 伸長と開花		話題提供者	今 村 駿 一 郎
b. ヤナギ類の花被		話題提供者	木 村 有 香

[C 会 場]

生 理

13.00—13.13 (C12)	カイネチン類緑化合物の葉の生長促進作用	{ 東大・理 徳島大・工	*倉 石 晉 奥 村 重 雄
13.15—13.28 (C13)	ジベレリン酸の同定方法とその植物組織内の移動について	京大・理	加 藤 次 郎
13.30—13.43 (C14)	ジベレリン酸のインドール酢酸破壊酵素に対する影響とインドール酢酸との分子間結合について	{ 京大・理 "	加 藤 次 郎 *勝 見 允 行
13.45—13.58 (C15)	ハマオモト種子の傷口に形成される色素中の生長作用物質	{ 奈良女子大・理 "	*吉 原 朝 子 小 清 水 卓 二
14.00—14.13 (C16)	ヒマワリの葉に含まれている生長阻害物質	{ 東大・理 "	*柴 岡 弘 郎 今 関 英 雅
14.15—14.28 (C17)	アカマツ花粉に含まれている生長抑制物質について	弘前大・文理	田 中 清
14.30—14.43 (C18)	側芽の伸長と抑制 (第6報)	京大・理	久 世 源 太 郎
14.45—14.58 (C19)	<i>Phaseolus</i> の蔓化について	{ 農 技 研 "	*村 上 浩 子 高 田 芳

[D 会 場]

生 理

13.00—13.13 (D11)	紅色細菌の呼吸	東大・理	加 藤 栄
13.15—13.28 (D12)	<i>Hydrogenomonas facilis</i> における窒素の代謝および <i>Azotobacter vinelandii</i> の細胞抽出液によるガス態窒素の固定	広島大・理	林 克 巳
13.30—13.43 (D13)	脱窒反応の研究 亜硝酸とヒドロキシルアミンの反応による酵素的ガス放出	{ 名大・理 "	*岩 崎 秀 一 森 森 健 志
13.45—13.58 (D14)	<i>Azotobacter</i> による亜硝酸の同化	{ 愛知女子大 名大・教養	*鈴 木 昇 旺 鈴 鈴 美 雄
14.00—14.13 (D15)	<i>Streptomyces griseus</i> の物質代謝 (第4報) グルタミン酸酸化について	{ 科 研 "	*井 中 山 弘 行 上 弘 美 雄
14.15—14.28 (D16)	りん酸代謝に及ぼすカリウムの影響 (第1報) 正常とカリウム不足の植物における P^{32} の吸収と分布 (予報)	{ 九大・教養 "	*山 下 知 治 小 長 光 与 壮
14.30—14.43 (D17)	水生顕花植物における P^{32} の吸収とその蓄積	福岡大・学芸	小 野 寺 正 二
14.45—14.58 (D18)	自記検出微量ガス代謝測定装置について	新潟大・教育	相 馬 悌 介

シンポジウム (3, 4) 13日 15.00—17.00 [C会場]

3. Cytotaxonomy に関する諸問題 15.00—16.00

a. キク科植物を材料として分類学の立場から	話題提供者	北 村 四 郎
b. キク科植物を材料として細胞学の立場から	話題提供者	小 野 記 彦

4. 下等隠花植物の体系と系統 16.00—17.00

a. 菌類の体系と系統	話題提供者	小 林 義 雄
b. 藻類の体系と系統	話題提供者	瀬 川 宗 吉

[A 会 場]

細 胞 ・ 遺 伝

9.00— 9.13 (A19)	海岸植物の核学的研究 (第3報)	横須賀・栄光高 浅 野 明
9.15— 9.28 (A20)	キイチゴ属の二三の自然雑種について	愛媛大・教育 神 野 太 郎
9.30— 9.43 (A21)	ヒガンバナ属の人工雑種について	{ 奈良学芸大 稲 荷 山 資 生 東京教育大・理 *竹 村 英 一
9.45— 9.58 (A22)	セン類の染色体数, 殊に特異な倍数性について	新潟大・教育 矢 野 孝 二
10.00—10.13 (A23)	<i>Aegilops squarrosa</i> 同質四倍体と Emmer コムギとの雑種第 1 代にあらわれた $2n=29$ 植物の染色体接合 (第2報)	東京農大・育種研 釜 野 井 正 男
10.15—10.28 (A24)	コムギ-カモジグサ 雑種の細胞遺伝学 (第1報) <i>Triticum durum</i> × <i>Agropyron elongatum</i> F ₁	群馬大・工 善 如 寺 厚
10.30—10.43 (A25)	3 染色体植物によるオオムギ連鎖群の研究 (続報)	{ 木 原 研 *土 屋 工 岡山大・大原農研 高 橋 二 郎 " 隆 平
10.45—10.58 (A26)	<i>Triticum georgicum</i> のゲノム分析	{ 遺 伝 研 *松 村 清 " 根 津 光 " 小 柴 幸 二 也 夫
11.00—11.13 (A27)	タンポポ属植物の細胞学的研究	岡山大・教育 竹 本 貞 一 郎
11.15—11.28 (A28)	ヨメナ属 (<i>Aster</i>) 植物の核型分析 (第5報)	神戸大・御影分校 藤 原 悠 紀 雄
11.30—11.43 (A29)	キク属の染色体数にいちじるしい差のある種間雑種	{ 広島大・理 *下 斗 米 直 昌 " 益 森 静 生 " 金 子 賢 一 郎

< 綜 合 討 論 >

[B 会 場]

分 類

9.00— 9.13 (B19)	和歌山県白浜温泉のケイ藻植生	{ 横浜市大・文理 福 島 博 " 小 林 艶 子
9.15— 9.28 (B20)	日本海産ラン藻類について	京大・農 梅 崎 勇
9.30— 9.43 (B21)	緑藻ランソウモドキ属の生活環	{ 九大・農 瀬 川 宗 東京教育大・理 *千 原 光 吉 雄
9.45— 9.58 (B22)	シダモクに関する研究 (追報)	九大・農 沢 田 武 男
10.00—10.13 (B23)	<i>Spermothamnion yonakuniensis</i> Yamada et Tanaka の形質について	新潟大・理 野 田 光 蔵
10.15—10.28 (B24)	カワモズク属の 1 種の生活環について	九大・農 吉 田 忠 生
10.30—10.43 (B25)	再びイデユコゴメ <i>Cyanidium caldarium</i> の所属について	神戸大・理 広 瀬 弘 幸
10.45—10.58 (B26)	紅藻 <i>Falkenbergia</i> の四分胞子とその発芽	{ 九大・農 *瀬 川 宗 吉 三重水産高 湖 城 重 仁
11.00—11.13 (B27)	日本産シャジクモ類 (第11報) <i>Chara globularia</i> Thuil. とその変異について	東京都立大・理 加 崎 英 男
11.15—11.28 (B28)	木崎湖におけるシャジクモ群落と変遷	{ 金沢大・理 今 堀 宏 " 須 賀 瑛 三 " 文

< 綜 合 討 議 >

[C 会 場]

生 理 ・ 生 態

9.00— 9.13 (C20)	シュウカイドウの無性芽形成 (第2報) 植物体の状態による日長感応性の差異	{ 東北大・理 " " " "	*江 刺 洋 司 江 口 木 允 彦 茂 尾 昌 之 長
9.15— 9.28 (C21)	シュウカイドウの無性芽形成 (第3報) 日 長条件による無性芽の形成と発芽の可逆性	東北大・理	江 刺 洋 司
9.30— 9.43 (C22)	短日効果の積算性	松本女専高	柴 田 治
9.45— 9.58 (C23)	茎, 地下茎, 根の極性に関する二三の知見	{ 東京学芸大 " " " "	*小 林 万 寿 男 西 村 和 子 岩 岡 悠 子 渡 部 一 郎
10.00—10.13 (C24)	カボチャ種子の光発芽性について	電力中央研	渡 部 一 郎
10.15—10.28 (C25)	種子の発芽に及ぼす代謝阻害剤の影響	熊本大・理	石 川 重 夫
10.30—10.43 (C26)	ハスの果実が長寿を保つ原因についての 考察	日大・藤沢高	豊 田 清 修
10.45—10.58 (C27)	クラミドモナス接合時の走化性物質 (第 1 報)	神戸大・理	坪 由 宏

< 綜 合 討 論 >

11.15—11.28 (C28)	志賀高原瓢箪池の花粉分析	大阪市大・理工	塚 田 松 雄
11.30—11.43 (C29)	宮城県下における中新世以降堆積物の花 粉分析	東北大・理	相 馬 寛 吉

< 綜 合 討 論 >

[D 会 場]

生 理

9.00— 9.13 (D19)	数種の酵母の培養に対する振とう効果	島根大・文理	西 上 一 義
9.15— 9.28 (D20)	清酒, パン, ぶどう酒酵母における胞子 形成条件	東北大・理	三 戸 信 人
9.30— 9.43 (D21)	ビオチン合成能を欠くパン酵母のビオチ ンおよびアスパラギン酸による異常形態 の出現について	東北大・理	倉 石 衍
9.45— 9.58 (D22)	酵母の1 紫外線変異株における二三のア ミノ酸の代謝関係	茨城大・文理	井 口 昌 一 郎

< 綜 合 討 論 >

10.15—10.28 (D23)	糸状菌によるろう, パラフィンの分解 (続報)	愛媛大・文理	宮 本 義 男
10.30—10.43 (D24)	<i>Penicillium purpurogenum</i> の色素生産 について (第3報)	静岡大・浜松分校	近 藤 武 夫
10.45—10.58 (D25)	葉腐菌の分離とその生理作用	千葉大・教育	山 田 保 々 木 昭 治 佐 下 慎 和 山 和 氣 和 民
11.00—11.13 (D26)	クロカビの生長生理 (予報)	{ 北大・理 " " " "	*山 本 昌 木 谷 野 淳 一
11.15—11.28 (D27)	<i>Phytophthora infestans</i> 胞子の発芽に関 する生理学的研究 (予報)	島根農大	*山 本 昌 木 谷 野 淳 一
11.30—11.43 (D28)	ガラスに発生する糸状菌の研究 空中湿 度と胞子発芽について	{ お茶の水大・理 " " " "	*大 槻 虎 男 今 井 百里江子

< 綜 合 討 論 >

[A 会 場]

細胞・遺伝・形態

9.00— 9.13 (A30)	ノビルの細胞学的研究 特になん性について	福岡学芸大 久留米分校	緒方茂利夫
9.15— 9.28 (A31)	<i>Plantago major</i> と <i>P. japonica</i> との間の生態学的比較	佐賀大・文理	藤原 勲
9.30— 9.43 (A32)	アカパンカビの2系統間の相互作用による菌体のメラニン化	阪大・理	桑 名 誉
9.45— 9.58 (A33)	エノキタケのリンケージ研究	岡山大・理	武丸恒雄
10.00—10.13 (A34)	帽菌類の diploidisation における核の行動	岡山大・理	木村 勲二

< 綜 合 討 論 >

10.30—10.43 (A35)	マツ科およびマキ科花粉の気嚢の変化	大阪市大・理工	上野実朗
10.45—10.58 (A36)	ホルトソウの生長点における前形成層の分化について	東大・理	相馬研吾
11.00—11.13 (A37)	ゼンマイ胞子の極性と仮根分化	名大・理	加藤幸雄
11.15—11.28 (A38)	ヒメジョオンの頭状花の配列測定 中心角をもちいずに3個の頭状花のなす角をもちいる方法	兵庫・洲本高	石上 晃
11.30—11.43 (A39)	開度と節間長との週期的変化(続報)	名大・教養	熊沢正夫

< 綜 合 討 論 >

[B 会 場]

細胞生理

9.00— 9.13 (B29)	フラズモ遊離細胞の生長成形について(第4報)	京都学芸大	山 段 忠
9.15— 9.28 (B30)	原形質流動の原動力と呼吸の同時測定(第4報)	阪大・理 " " " "	*阿部重美 中島通郎 神谷 宣
9.30— 9.43 (B31)	顕微注射による変形体原形質流動の生理学的研究	阪大・理	高田 充
9.45— 9.58 (B32)	変形体の収縮性たんぱく質(第2報)	阪大・理	中島宏通
10.00—10.13 (B33)	変形体の電位のリズムについて	阪大・理	岸本卯一郎
10.15—10.28 (B34)	単一植物細胞の浸透特性(第6報)	阪大・理	森 祐二
10.30—10.43 (B35)	細胞の浸透調節作用に関する研究(第3報)	阪大・理	永井玲子
10.45—10.58 (B36)	フラズモの原形質流動と働作流との関係について	阪大・理 " " " "	*岸本卯一郎 赤堀弘道 高田 充
11.00—11.13 (B37)	カサノリの遊離原形質滴の運動について	阪大・理	高田 充
11.15—11.28 (B38)	フラズモの遊離原形質滴の諸性質	阪大・理 " " " "	神谷宣郎 黒田清子 *神谷宣郎 黒田清子
11.30—11.43 (B39)	周回原形質流動の力学	阪大・理 " "	*神谷宣郎 黒田清子

< 綜 合 討 論 >

〔 C 会 場 〕

生 態

9.00—9.13 (C39)	ブナ落葉の分解過程について	東北大・北分校	斎 藤 紀
9.15—9.28 (C31)	森林群落の階層区分について	北大・農 " " 東京都立大・理 " " " " 茨城大・文理 東大・理 " " " " " "	齋 藤 達 欣 宣 一 操 館 井 康 康 夫 辻 宝 月 郎 大 木 島 村 伯 允 木 本 城 夫 郎 野 佐 城 雄 績 佐 岩 黒 戸 太 黒 戸 岩 佐 木 一 戸 岩 佐 木 悦 飯 飯 泉 茂
9.30—9.43 (C32)	縞枯山森林の生態調査報告 (第1報)	北海道・富良野高 北海道・愛山中 宮城・岩ヶ崎高 東北大・理	齋 藤 藤 太 佐 木 木 岩 佐 原 亀 黒 戸 泉 茂
9.45—9.58 (C33)	北海道のセンタイ類 (第3報) ハイマツ群落におけるセンタイ類	北海道・富良野高 北海道・愛山中 宮城・岩ヶ崎高 東北大・理	齋 藤 藤 太 佐 木 木 岩 佐 原 亀 黒 戸 泉 茂
10.00—10.13 (C34)	いわゆる“馬たてば”の植群について	北海道・富良野高 北海道・愛山中 宮城・岩ヶ崎高 東北大・理	齋 藤 藤 太 佐 木 木 岩 佐 原 亀 黒 戸 泉 茂
< 綜 合 討 論 >			
10.30—10.43 (C35)	北海道東部湿性牧野のスゲ類群落	北大・農	辻 井 達 一
10.45—10.58 (C36)	東北海道泥炭地の特異植生“やちぼうず”の構造について	北海道学芸大 釧路分校	田 中 瑞 穂
11.00—11.13 (C37)	太田川流域における竹林の群落構造について	広島大・理 " "	堀 川 芳 雄 松 村 敏 則
11.15—11.28 (C38)	河川の高水敷群落の構造	千葉大・文理 " " " "	沼 田 真 三 寺 雄 延 原 肇 西 村 光 小 原 幸 細 川 隆 英
11.30—11.43 (C39)	着生植物の方向性	九大・理 " " " "	西 村 幸 隆
< 綜 合 討 論 >			

〔 D 会 場 〕

生 理

9.00—9.13 (D29)	緑藻、石灰藻の有機酸およびその脱水素酵素作用について	東京学芸大 " " " " 東京教育大・理	*古 谷 庫 造 黒 住 上 玉 村 三 輪 子 三 井 健 雄
9.15—9.28 (D30)	耐塩菌チトクロームに関する二三の知見	名古屋市大・教養 名大・理	*平 森 一 男 大 佐 健 志
9.30—9.43 (D31)	細菌の生長過程における発酵能の変化	北大・理 " "	*笠 巻 明 子 佐 々 木 昭 治
9.45—9.58 (D32)	細菌の酸化能に対する温度の影響	北大・理 " "	*仲 尾 澄 子 宇 佐 美 正 一 郎
10.00—10.13 (D33)	<i>Azotobacter</i> の酵素の生成について	北大・理	前 田 喜 美 子
10.15—10.28 (D34)	霜害の研究 茶葉の浸透圧について	京大・気象研	村 田 茂 三
10.30—10.43 (D35)	サツマイモにおける物質移動と温度との関係	九大・農 " "	*関 島 均 行
10.45—10.58 (D36)	植物の水分経済に及ぼす光週処理効果、特に蒸散量、細胞浸透価および水分透過性の相互関係について	下関商高	賀 来 章 輔
11.00—11.13 (D37)	異常条件においた幼植物の体内水分の消長	別府大	二 宮 淳 一 郎
11.15—11.28 (D38)	膨潤圧による原形質の吸水強度と浸透圧による容水能との関連について	広島大・理	福 田 八 十 楠
11.30—11.43 (D39)	植物体内生態学の提唱	福岡女子大	額 額 理 一 郎
< 綜 合 討 論 >			

[A 会 場]

形 態

9.00—9.13 (A40)	メタセコイアおよびその近縁種の菌根について	大阪市大・理工	近 衛 廉 也
9.15—9.28 (A41)	ツツジ科の脈系の発達	東大・理	原 襄
9.30—9.43 (A42)	セン類のさく歯の発生学的研究 (第5報)	島根大・文理	斎 藤 真 太 郎
9.45—9.58 (A43)	セン類の胞子の発芽について (第1報) タマゴケ, ネジクチゴケ, ツリガネゴケについて	{ 島根大・文理 " }	西 田 雄 行 * 斎 藤 真 太 郎
10.00—10.13 (A44)	モエジマシダの初期前葉体の生長様式	{ 名大・理 " }	* 菅 井 道 三 原 田 市 太 郎
10.15—10.28 (A45)	シダの原糸体その他における細胞壁の生長	名大・教養	高 橋 千 裕
10.30—10.43 (A46)	シダの原糸体細胞の伸長について	名大・理	伊 藤 道 夫
10.45—10.58 (A47)	アミノ酸アナログとヌクレオチド・アナログのシダ前葉体での2次元分化への影響	名大・理	堀 田 康 雄
11.00—11.13 (A48)	オオイシソウの発芽について	{ 東大・農 " }	野 沢 治 治 野 沢 ユ リ 子
11.15—11.28 (A49)	ヒパマタ科藻類の第一次分化について	山形大・文理	中 沢 信 午
11.30—11.43 (A50)	コンプ目植物の比較形態発生的研究	{ 岡山山大・理 " }	* 猪 野 俊 平 西 林 長 朗

< 綜 合 討 論 >

[B 会 場]

細 胞 ・ 生 理

9.00—9.13 (B40)	糖質トウモロコシ胚乳の細胞におけるホスホリラーゼの分布	{ 大阪学芸大 池 田 分 校 }	* 田 中 国 治 森 岡 喬 樹
9.15—9.28 (B41)	アカビートの耐凍性とホスホリラーゼ	北大・低温研	照 本 勲
9.30—9.43 (B42)	原形質膜の防凍性	北大・低温研	朝 比 奈 英 三
9.45—9.58 (B43)	シャジクモ節間細胞の興奮にともなう膜抵抗および膜容量の変動	東北大・理	小 田 健 二
10.00—10.13 (B44)	シャジクモの節部をこえる興奮の伝達	東北大・理	柴 岡 孝 雄
10.15—10.28 (B45)	フクシン抽出法によるフォイルゲン反応の解析	京大・理	平 岡 俊 佑
10.30—10.43 (B46)	フォイルゲン反応に対するたんぱく質の影響	京大・理	石 田 政 弘
10.45—10.58 (B47)	オジギソウの細胞生理学的研究 (第9報)	東京女子大	鳥 山 英 雄
11.00—11.13 (B48)	オジギソウに及ぼす弱光の刺激効果について	宮城農短大	遠 藤 沖 吉
11.15—11.28 (B49)	花粉発芽に及ぼすアミノ酸の影響について	北海道学芸大 旭 川 分 校	沢 田 義 康
11.30—11.43 (B50)	でんぷん花粉の発芽について	愛知学芸大	森 隆 也

< 綜 合 討 論 >

〔C 会 場〕

生 態

9.00—9.13 (C40)	附着性微小藻類の一定量法	〔横浜市大・文理 " 〃	*福 島 正 博 一 戸 欣 憲 宝 市 俊 二 村 本 英 本 充 充 村 条 英 本 八 東 坂 本 充 西 本 夫 坂 本 郎 " 〃
9.15—9.28 (C41)	植物プランクトンの物質生産と湖沼変移の関係について	〔東京都立大・理 東京教育大・理 東京都立大・理	*一 宝 月 博 市 村 本 二 坂 本 英 " 〃
9.30—9.43 (C42)	二三の水域のクロロフィル含量と生産力について	〔東京教育大・理 東京都立大・理 " 〃	*市 村 俊 英 西 本 八 東 坂 本 充 " 〃
9.45—9.58 (C43)	新しい植物生長の理論(その1) 生長曲線と生長要因の作用函数	〔大阪市大・理工 大阪市大・医	*吉 良 竜 夫 篠 崎 吉 郎 " 〃
10.00—10.13 (C44)	新しい植物生長の理論(その2) 線型要因(光、土じょう水分、栄養塩類その他)について	大阪市大・理工	生 嶋 功
10.15—10.28 (C45)	新しい植物生長の理論(その3) 線型要因間の相互作用について	大阪市大・理工	穂 積 和 夫
10.30—10.43 (C46)	同化組織の垂直分布構造の理論的考察	東大・理	佐 伯 敏 郎
10.45—10.58 (C47)	イチョウの発芽、落葉等の個性性について 生物季節とその利用(第3報)	豊橋東高	倉 内 一 二
11.00—11.13 (C48)	常緑広葉樹の光合成の季節変化について	鹿児島大・教育	楠 元 司
11.15—11.28 (C49)	切断根系の呼吸の不自然性(第3報) つぎ木ならびに葉の病変の影響	〔東大・理 " 〃	*高 橋 基 生 鎌 田 久 福 " 〃
11.30—11.43 (C50)	根系呼吸に及ぼす過酸化水素、糖類ならびに有機酸の影響と銅塩の場合との比較	〔東大・理 三菱鉱山研	*高 橋 基 生 渡 辺 庄 美 " 〃

< 綜 合 討 論 >

〔D 会 場〕

生 理・生 化

9.00—9.13 (D40)	イネの発芽期の呼吸系	〔北大・理 " 〃	*桑 山 弥 寿 男 宇 佐 美 正 一 郎 " 〃
9.15—9.28 (D41)	コムギの播種性のちがいによる代謝系の相違について(予報)	〔北大・理 " 〃	*寺 岡 宏 宇 佐 美 正 一 郎 " 〃
9.30—9.43 (D42)	コリヤナギのポリフェノラーゼに関する研究	〔資 源 研 " 〃 東邦大・理	*松 崎 悦 三 大 林 弘 幸 薬 師 寺 英 次 郎 " 〃
9.45—9.58 (D43)	種子発芽期におけるプロトヘミン体の分布とその変動	〔名大・理 " 〃	*森 健 久 志 森 子
10.00—10.13 (D44)	ジュウニヒトエの無細胞液によるガラクトース転移反応について	〔東大・理 " 〃	*藤 田 善 彦 服 部 静 夫 " 〃
10.15—10.28 (D45)	咲き分けツバキのロイコアントシアン	遺 伝 研	遠 藤 徹
10.30—10.43 (D46)	チカラシバの花穂における色素について	〔富山大・文理 " 〃	*柴 田 万 年 堺 恵 美 " 〃
10.45—10.58 (D47)	クロユリの花の色素について	〔富山大・文理 " 〃	*柴 田 万 年 堺 恵 美 " 〃
11.00—11.13 (D48)	植物の生育ならびに内部成分に及ぼすアルカリ塩類の影響	韓国・ソウル大 師 範 大	金 遵 敏
11.15—11.28 (D49)	濁度測定に関する二三の問題(第2報) 葉緑体の構成成分の分離	京大・理	桃 谷 好 英
11.30—11.43 (D50)	超遠心による葉緑体たんぱく質の研究	九大・理	千 葉 保 胤

< 綜 合 討 論 >

特 別 講 演 10月13日(日): 13.00-15.00

E. H. Walker Adventure in Japanese Botany

その他未定

記 念 講 演 10月14日(月) 15.30-17.00

日本植物学会七十五年史

大会会長

小 倉

謙

明治時代の学会の思い出

草 野

俊 助

大正以降の学会余談

篠 遠

喜 人

日本植物分類学会

生理談話会

日 時 10月13日(日) 18.00-

日 時 10月13日(日) 18.00-20.00

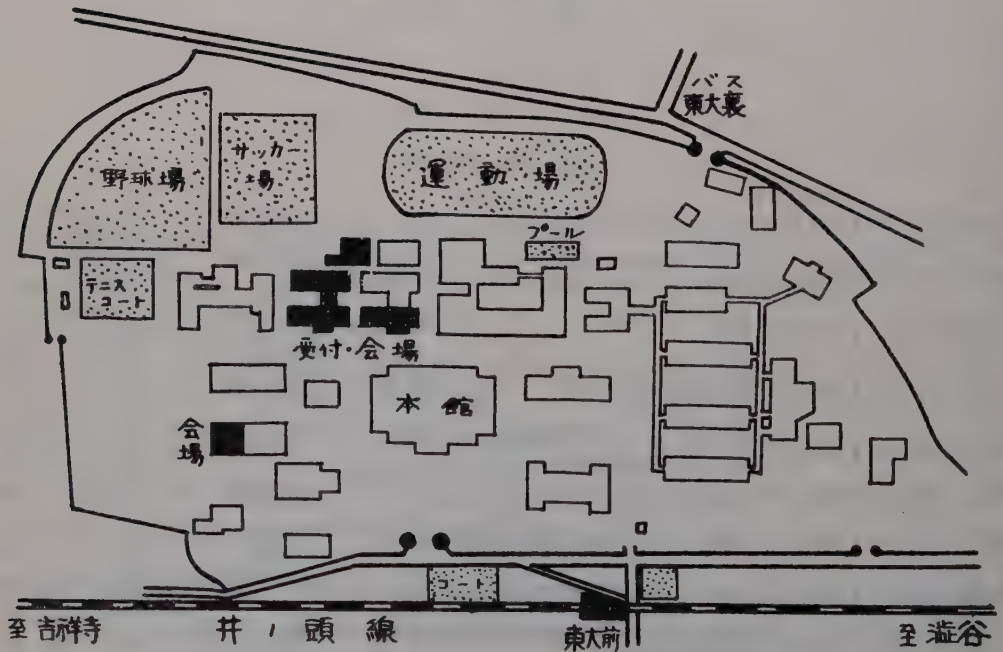
場 所 東大・教養学部10大教室

場 所 東大・教養学部11大教室

テーマ 高等植物組織の生長について

東京大学教養学部略図

(国電・渋谷駅乗換え、井の頭線・東大前下車)



東京都文京区本富士町 東京大学理学部植物学教室

日本植物学会 75周年記念大会準備会

Physiological and Ecological Studies on the Plant Production in Plant Communities

4. Ecological Studies on the Apparent Photosynthesis Curves of Evergreen Broad-Leaved Trees

by Tsukasa KUSUMOTO

楠元 司：植物群落に於ける植物生産に関する生理生態学的研究
4. 常緑広葉樹の光合成曲線の生態学的研究

Received June 24, 1957

The composition and structure of the evergreen broad-leaved forest which is the climax community in the warm-temperate region of Japan, has been studied by such many investigators as Nakano (11), Suzuki (13, 14, 15), Kira (5), etc.. However, the effects of various factors which affect the structure and development of the community, were not thoroughly analysed from the physiological and ecological viewpoints. Among the environmental factors relating to this problem, it is supposed that the light is the most important one. The relationship between the structure and development of plant community and the light factor has been studied in detail by Boysen-Jensen (3), Monsi and co-workers (8, 9, 10) on the basis of the dry matter production in herb and deciduous plant communities. Walter (16), Baker (1) studied also on the same standpoint. Nomoto (12) analysed the succession of the deciduous broad-leaved forest by the same idea, but, so far as the author knows, it seems that a study of the evergreen broad-leaved forest in Japan has scarcely been carried out from such standpoint as mentioned above.

From this reason, it may be safely asserted that needs are to obtain the apparent photosynthesis curves of the evergreen broad-leaved trees, which are fundamental data for the study of dry matter production (plant production) and for the analysis of succession of this forest community.

Materials and Methods

The 12, dominant and characteristic species in the three associations in Oosumi peninsula (Suzuki (13)) were selected for the materials. Those are *Shiia Sieboldii*, *Machilus Thunbergii*, *Distylium racemosum*, *Eurya japonica*, *Myrica rubra*, *Rapanaea neriifolia*, *Lithocarpus edulis*, *Illicium religiosum*, *Symplocos lucida*, *Quercus glauca*, *Camellia japonica* and *Cinnamomum Camphora*.

The leaves of those trees growing in the natural condition were used for the

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measurement of photosynthesis and respiration by mean of Boysen-Jensen's method (3, 6). Illumination intensities were provided by changing the distance of 500-Watt reflector flood lamp from the assimilation chamber. The illumination intensity was measured by the Mazuda photometer. The temperature in the chamber which was held in the water bath, was kept at 25°C constant. The leaf area was measured by the planimeter.

More than thirty measurments were made in summer 1956 in order to obtain one curve.

Results and Discussion

From the apparent photosynthesis curves of the sun and the shade leaf of each species shown in Fig. 1, the important figures are collected in Table 1.

These figures show that the greater part of the tested plants possess the character of shade plants such as small value of maximum-photosynthesis, respiration and compensation point, and that *C. Camphora* has somewhat the character of sun plant rather than shade plant. These curves progress strikingly similar to those reported by Lundegårdh (7), Boysen-Jensen (3), Böhning and Burnside (2), namely, the light saturation occurred at an intensity of 1/3 of the full day light intensity in the sun leaf and at 1/10 in the shade leaf.

Considering the figures shown in Table 1, it is remarkable that R/P ratio of the shade leaf of *M. Thunbergii* is as large as 0.27 owing to its low photosynthetic and high respiratory activity, and that the ratio of *S. lucida* is fairly small (0.08) because of its low respiratory activity.

Fig. 1 gives some presumptions on the development of the community, namely, when all species grow under the full day light, the species of the larger net production may be able to dominate over the other. However, as the competition begins generally in the shade habitats of a community, it is necessary to know the production of plant under weak light condition.

The compensation points of these plants are likely important on the matter production in shade, but Lundegårdh (7), Stålfelt (1), Decker (4) recognized that some of the very tolerant species have the higher grade of compensation point. This fact was also recognized in this experiment. It is somewhat difficult to anticipate the structure and development of the community in future from these curves. In order to explain clearly the fate of seedlings of the 12 species in shade habitats, the relative daily photosynthetic production of each species is calculated and shown in Fig. 2.

The relative daily production was calculated from the photosynthesis curves in Fig. 1 and the mean light intensities at different times of day in summer at Kagoshima prefecture, viz., 5.30-6, 19-19.30, 0.8 KLux; 6-7, 18-19, 8 KLux; 7-10, 14-18, 47.5 KLux; 10-11, 13-14, 49.4 KLux; 11-13, 50 KLux; this mean light intensity was reformed temporarily from Monsi's result measured in Tokyo.

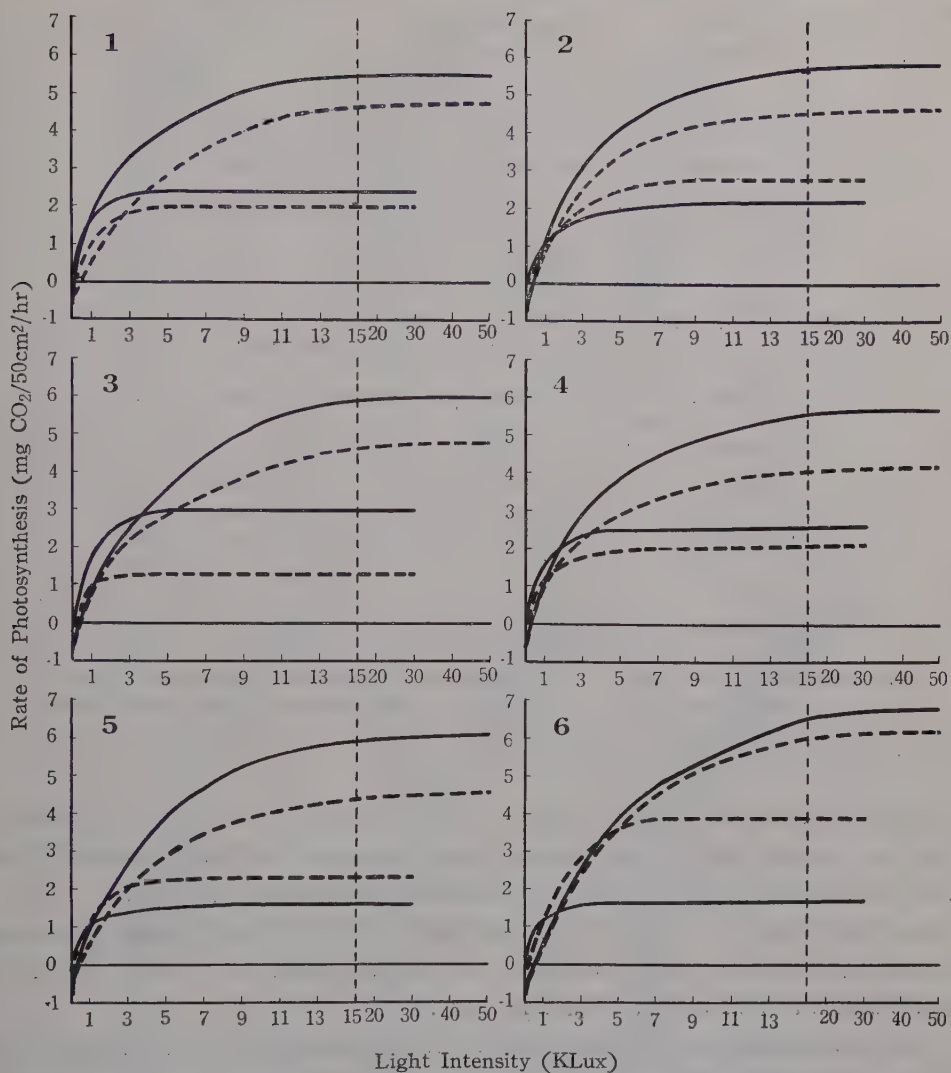


Fig. 1. The apparent photosynthesis curves of the sun leaf (upper curve) and the shade leaf (lower curve) of each species.

1. — *S. Sieboldii*, ---- *R. neriifolia*; 2. — *D. racemosum*, ---- *I. religiosum*;
 3. — *Q. glauca*, ---- *M. Thunbergii*; 4. — *E. japonica*, ---- *C. japonica*;
 5. — *L. edulis*, ---- *M. rubra*; 6. — *S. lucida*, ---- *C. Camphora*

Table 1. This table is summarized from Fig. 1 and Fig. 2.

Plants	in the shade leaf					in the sun leaf				
	R.	C.P.	P.	R/P	D.P. C.	R.	C.P.	P.	R/P	D.P. C.
<i>S. Sieboldii</i>	0.292	50	2.4	0.12	0.4	0.608	150	5.5	0.11	0.9
<i>M. Thunbergii</i>	0.350	100	1.3	0.27	0.9	0.700	300	4.8	0.15	2.0
<i>D. racemosum</i>	0.254	80	2.2	0.12	0.7	0.699	300	5.8	0.12	1.1
<i>Q. glauca</i>	0.333	100	3.0	0.11	0.7	0.579	350	6.0	0.10	2.0
<i>L. edulis</i>	0.328	80	1.6	0.21	0.8	0.808	390	6.1	0.13	2.5
<i>M. rubra</i>	0.305	120	2.3	0.13	0.7	0.604	400	4.6	0.13	2.5
<i>C. japonica</i>	0.256	100	2.1	0.12	0.6	0.622	400	4.2	0.15	2.5
<i>E. japonica</i>	0.227	50	2.6	0.09	0.6	0.655	350	5.7	0.11	1.5
<i>S. lucida</i>	0.135	50	1.7	0.08	0.3	0.600	450	6.8	0.09	2.0
<i>R. neriifolia</i>	0.215	80	2.0	0.11	0.6	0.511	400	4.7	0.11	2.0
<i>I. religiosum</i>	0.367	150	2.8	0.13	0.7	0.727	480	4.6	0.16	2.0
<i>C. Camphora</i>	0.454	200	3.9	0.12	1.0	0.801	600	6.2	0.13	2.5

R.....respiration rate (mg), P.....maximum rate of apparent photosynthesis (mg), C.P.....compensation point (Lux), R/P.....ratio between respiration rate and maximum rate of apparent photosynthesis, D.C.P.....compensation point of daily relative production rate (%).

At the high relative light intensities, the expectation for the relative production rate of each species may be the same as was represented in Fig. 1, therefore, those at the low relative light intensities as below 30 % are shown in Fig. 2.

Monsi and Saeki (8) reported that the relative light intensity under the canopy of *Shiia cuspidata* forest was 2.5-5 %. The author found 1-2 % of it in the *S. Sieboldii* forest at Shiroyama, Kagoshima city.

Since the compensation points of the relative production rates (rel. light intensity %, see Table 1) of all species are lower than the relative light intensities of the forest inside mentioned above, they can grow in this habitat. However, these species were not always found in this forest. The growth of seedling under such weak light intensity as at the compensation point, must be analysed in future from the viewpoint of matter production.

From Fig. 2, the author can conclude the order of the relative production rate at the relative light intensities above the compensation points as following. In the shade leaf, *S. lucida*>*M. Thunbergii*>*E. japonica*>*R. neriifolia*>*S. Sieboldii*>*Q. glauca*>*C. japonica*>*M. rubra*>*L. edulis*>*D. racemosum*>*I. religiosum*>*C. Camphora*; in the sun leaf, *S. Sieboldii*>*I. religiosum*>*D. racemosum*>*C. japonica*>*E. japonica*>*L. edulis*>*M. rubra*>*Q. glauca*>*R. neriifolia*>*M. Thunbergii*>*S. lucida*>*C. Camphora*. The order of the sun leaf is nearly in the reverse ordering of the

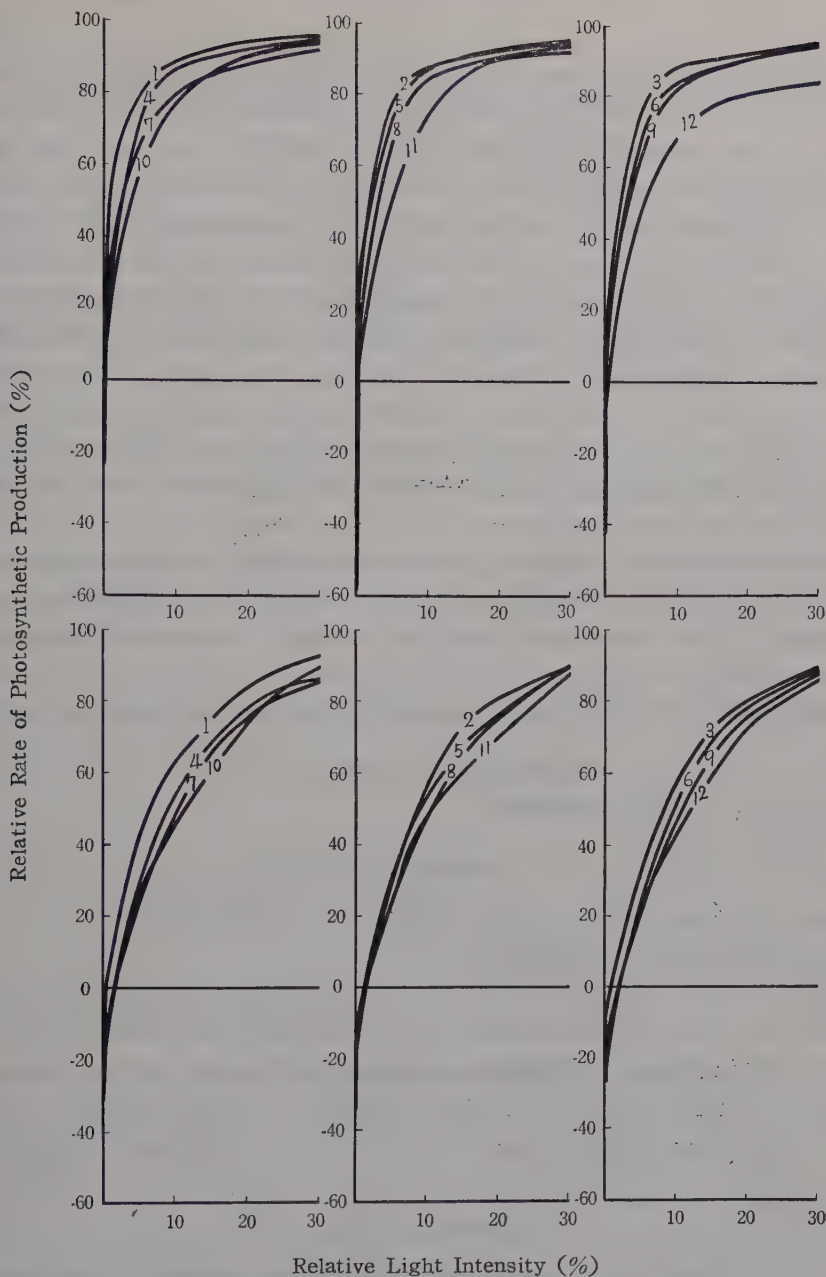


Fig. 2. The relative daily photosynthetic production under different relative light intensities. Values of the shade leaf of each species are shown in the three figures above and those of the sun leaf in the three figures below. The numbers of the shade leaf represent the species as following;

1. *S. lucida*, 2. *M. Thunbergii*, 3. *E. japonica*, 4. *R. neriifolia*, 5. *S. Sieboldii*,
 6. *Q. glauca*, 7. *C. japonica*, 8. *M. rubra*, 9. *L. edulis*, 10. *D. racemosum*, 11.
I. religiosum, 12. *C. Camphora*

The numbers of the sun leaf represent the species as following;

1. *S. Sieboldii*, 2. *I. religiosum*, 3. *D. racemosum*, 4. *C. japonica*, 5. *E. japonica*,
 6. *L. edulis*, 7. *M. rubra*, 8. *Q. glauca*, 9. *R. neriifolia*, 10. *M. Thunbergii*,
 11. *S. lucida*, 12. *C. Camphora*

shade leaf.

From this result, it may be expected that the relative production rates of the shade leaf of *S. lucida* and *M. Thunbergii* are higher and those of the sun leaf are lower at the low relative light intensity as compared with the other species, and they can grow favourably in the shade habitats of lower relative light intensity when they have shade leaves. On the other hand, *I. religiosum* and *D. racemosum* had reverse characters, and so it is favourable to have sun leaves and to reside in the habitats of higher light intensity. Because both of the sun and the shade leaves of *S. Sieboldii* had the high productivity, it may be possible to be a dominant. *E. japonica* and *C. japonica* can clearly grow in many associations. *R. neriifolia*, *Q. glauca*, *M. rubra* and *L. edulis* become respectively the characteristic species in the particular association, for it seems that these species are mainly influenced by some other factors in addition to the light. Further, it is demonstrated that *C. Campora* can not occur in the three associations.

It is recognized that the relative light intensity influencing the plant production of each species produces the differences on their developments and further controls the development of the community. From this reason, it is believed that the structure and development of communities may be possibly analysed by the photosynthesis curves, though the other environmental factors must be considered.

The author wishes to express his best thanks to Prof. M. Monsi of the Tokyo University for his valuable suggestion.

Summary

The apparent photosynthesis curves of the sun and the shade leaf of the ever-green broad-leaved trees are presented.

The twelve species which selected for the materials were the dominant and the characteristic species in the forest which is the climax community of the warm-temperate region in Japan. Ecological analysis on the structure and development of this community was carried out on the basis of the concept of the plant production (matter production) by making clear the apparent photosynthesis curve of each species.

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The Plant Ecological Studies of Lakes and Marshes having a Period of Drainage

III. On the Amphiphyte-Zone in Artificial Reservoirs*

by Shôen KAMURO**

香室昭円**： 渇水期を有する湖沼の植物生態学的研究

III. 人工貯水池における両生植物帯について*

Received July 3, 1957

The present writer recognized two typical type of macrophyte vegetation, namely the regular zonal type and the massive type, both of which appear after drainage in some artificial reservoirs in Japan.^{9,10)} These reservoirs may be regarded as belonging to the vernal autumnal type of temporary ponds. Besides these types he detected an intermediate type between the two typical types in some reservoirs in Shiga Prefecture.

These types are observed to be markedly different from each other in community composition of amphiphyte zones, which fact is most indicative in many fresh-water ecosystems.

The present study was undertaken to clarify the community composition of the amphiphyte zones of three vegetation types with some ecological considerations.

The writer must record his deepest thanks to Dr. Y. Horikawa, Prof. of Botany in Hiroshima University and Dr. K. Tsuneki, Prof. of Biology in Fukui University, for their very valuable advice and encouragement during the course of the present study. He must also thank Dr. K. Imahori, Kanazawa University, for kindly reading and criticizing this manuscript.

Pond Basin and Investigation Method

About thirty reservoirs investigated are rather small water bodies in volume which range from about 0.5 km to 4.0 km in circumference and from about 2.0 m to 4.0 m in depth at high-water line. The basins of these reservoirs are generally not so strikingly changed as many lakes and accordingly they have rather simple aspects. However the writer distinguished three topographical areas, that is to say, the marginal, the littoral and the central part, in some reservoirs with a rather youthful basin which generally exhibited the zonal arrangement of vegetation. Some reservoirs with older basins exhibiting the massive vegetation, have their littoral areas which spread over the pond bottoms with thick layers of biotic remains or abiotic sedi-

* A part of the present study was delivered at the 20th annual meeting of the Botanical Society of Japan, October, 1955.

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ments. Drainage of these reservoirs begins in May rice-transplanting season, and their bottoms will be dried up completely in September, accordingly so-called “Verlandung” will be found.

The writer drew the primary survey maps of macrophyte vegetations of these reservoirs after drainage and further made an attempt to analyse these vegetations by the method of belt transect whose breadth is 1 m, as usually-employed in some herbaceous communities.

Only in a few reservoirs of the vegetation of massive type, however, he used the belt of 50 cm in breadth. After the belt transect researches were made, he adopted a grid system of 1 m square by purposive selection, to estimate the frequencies and the covering degrees of all components involved in each dominant communities.

Vegetation

It can be generally noted that each vegetation developed on the pond bottom after drainage, exhibits much enclosed community composition because of the diversified habitat conditions after the remarkable change of environment, contrary to vegetation of the natural steady hydrospheres in hydric conditions. Especially is vegetation of littoral areas often markedly different in community composition from vegetation of many lakes.

Table 1. The Vegetation of the First Type*

	The Marginal Part	The Littoral Part	The Central Part
The Principal Vegetation Change	The Terrestrial Zone (Certain terrestrial components sensitive to inundation)	The Amphibious Zone (Certain amphibious and hygrophytic plants)	The Aquatic Zone (Certain aquatic plants)
The Principal Dominants	<i>Rosa multiflora</i>	<i>Lysimachia Fortunei</i> <i>Dimeria ornithopoda</i> var. <i>Paspalum Thunbergii</i> <i>Carex Thunbergii</i>	<i>Brasenia Schreberi</i>
	<i>Pleiblastus pygmaea</i> var. <i>glabra</i>	<i>Lobelia chinensis</i> <i>Centipeda minima</i>	<i>Myriophyllum ussuriense</i>
	<i>Triadenum japonicum</i> <i>Lythrum anceps</i>	<i>Eleocharis pellucida</i>	<i>Nuphar japonicum</i>
The Main Accompanying Components	<i>Ilex crenata</i> <i>Salix Gilgiana</i> <i>Quercus serrata</i> <i>Q. mongolica</i> var. <i>grosseserrata</i> <i>Pinus Thunbergii</i> <i>Imperata cylindrica</i> var. <i>Koenigii</i> <i>Miscanthus sinensis</i> <i>Paspalum Thunbergii</i> <i>Centipeda minima</i> <i>Eriocaulon Miquelianum</i>	<i>Triadenum japonicum</i> <i>Isachne globosa</i> <i>Cyperus serotinus</i> <i>Eriocaulon Miquelianum</i> <i>Hedyotis diffusa</i> <i>Fimbristlis aestivalis</i> <i>Myriophyllum ussuriense</i> <i>Scirpus lineolatus</i> <i>Brasenia Schreberi</i> <i>Gratiola violacea</i>	<i>Potamogeton octandrus</i> var. <i>Miduhikimo</i> <i>Eleocharis pellucida</i> <i>Fimbristlis diphylloides</i>

* The shore zonation terminology of Table 1,2 and 3 was cited from the survey of H. at Ranzien H⁶).

Three typical types namely the first, the second and the third type of the macrophyte vegetation developed after drainage, in artificial reservoirs investigated, are shown in Tables 1, 2 and 3. As shown in these tables, three types are most distinctly different in community composition of the amphiphyte zone which occupies the littoral areas, in spite of the resemblance of the marginal and the central system.

The vegetation of the first type tends to denote the typical zonal arrangement, in which each predominant community alternates abruptly with the next successor. Especially it may be a noticeable fact that the amphiphyte zone on the littoral areas in this type is predominated by communities of such small-stemmed hygrophilous perennial plants or such annual plants as *Dimeria ornithopoda* var. *tenera*, *Lobelia chinensis* and *Eleocharis pellucida*, which are generally displaced by large-stemmed emergent plants, namely *Phragmites* or *Zizania* in many natural hydrospheres. These communities succeeded by aquatic plant communities predominated by *Brasenia Schreberi*, *Myriophyllum ussuriense* and *Nuphar japonicum*.

Table 2. The Vegetation of the Second Type

	The Marginal Part	The Littoral Part	The Central Part
The Principal Vegetation Change	The Terrestrial Zone (Certain terrestrial components sensitive to inundation)	The Amphibious Zone (Certain amphibious and hygrophytic plants)	The Aquatic Zone (Certain aquatic plants)
The Principal Dominants	<i>Rosa multiflora</i>	<i>Phragmites communis</i>	<i>Brasenia Schreberi</i> <i>Trapa japonica</i> <i>Potamogeton distinctus</i>
		<i>Zizania latifolia</i>	
The Main Accompanying Components	<i>Miscanthus sinensis</i>	<i>Eleocharis Kuroguwai</i>	<i>Nuphar japonicum</i> <i>Ceratophyllum demersum</i>
		<i>Scirpus Preslii</i> <i>Oenanthe javanica</i> <i>Hedyotis diffusa</i> <i>Ludwigia ovalis</i> <i>Sparganium stoloniferum</i> <i>Eleocharis pellucida</i> <i>Carex Thunbergii</i>	
	<i>Quercus serrata</i> <i>Salix Gilgiana</i> <i>Isachne globosa</i> <i>Lythrum anceps</i> <i>Scirpus Wichurai</i> <i>Pleioblastus pygmaea</i> var. <i>glabra</i>		<i>Potamogeton natans</i> <i>P. octandrus</i> var. <i>Midu-hikimo</i> <i>Utricularia pilosa</i> <i>Hydrocharis asiatica</i> <i>Nymphaea tetragona</i> <i>Hydrilla verticillata</i> <i>Myriophyllum spicatum</i> <i>M. ussuriense</i>

The third vegetation type is strikingly different from the first type in massive vegetation predominated by such large-stemmed emergent plants as *Phragmites* and *Scirpus* which spread into the amphiphyte zone of littoral and central areas. Furthermore, it may be noted that no trace of the aquatic plant can be found in this vegetation type. From these facts this vegetation type will be thought to be a seral stage succeeding from the sedge marsh to the reed swamp, proceeding to complete terrestrial vegetation.

The second vegetation type, if anything, has a resemblance with that of the permanent ponds, which have three zones of the emergent, the floating-leaved and the

Table 3. The Vegetation of the Third Type

	The Marginal Part	The Littoral Part	The Central Part
The Principal Vegetation Change	The Terrestrial Zone (Certain terrestrial components sensitive to inundation)	The Amphibious Zone	
The Principal Dominants	<i>Rosa multiflora</i>	<i>Phragmites communis</i> <i>Scirpus Preslii</i>	
	<i>Miscanthus sinensis</i>		
	<i>Lythrum anceps</i>		
The Main Accompanying Components	<i>Salix Gilgana</i> <i>Populus Sieboldi</i> <i>Quercus serrata</i> <i>Rubus parvifolius</i> <i>Carex Thunbergii</i> <i>Paspalum Thunbergii</i> <i>Paederia scandens</i> <i>Lysimachia Fortunei</i>	<i>Eleocharis mamillata</i> var. <i>cyclocarpa</i> <i>E. pellucida</i> <i>Isachne globosa</i> <i>Scirpus lineolatus</i> <i>Ludwigia ovalis</i>	

submerged plant community, as also seen in most of the lenitic habitats of lakes. And this type is distinctly different from the first type by the presence of the large-stemmed emergent plants, *Phragmites* and *Zizania*, immigrated into the littoral amphiphyte zone, and is also remarkable different from the third type by the presence of the distinct submerged and floating-leaved plant zones and of the small and the large-stemmed emergent plant communities in zonal arrangement.

Discussion and Conclusion

It has been considered that the biotic systems in the fresh water ecosystems are remarkably reconstructed by water depth, especially by the fluctuation of water depth, which is the most limiting factor in hydric conditions.^{4 6 7 10 13 15} The writer has also recognized in many artificial reservoirs that the bottom communities appear distinctly after drainage, and also that those dominants and subdominants have considerable positive aelation with the depth of the high-water line. Besides he assumed that hydrarch is more closely related with the fluctuation of water depth compared with other habitat conditions in a reed swamp. It is also detected that the physical and chemical characters of soil and water delimit the distribution type of the communities in many aquatic ecosystems.^{1 2 3 8 11 12} The writer found that the inclination and the soil humidity will especially delimit the community structure on the littoral areas in a reservoir after drainage. Furthermore, he assumed in the preliminary study on a reed swamp, that vegetation in a swamp is considerably related to chemical conditions of bottom soil.

From these facts it may be said that the abiotic factors involved in the basins of the reservoirs will be important for the community development, especially for the amphiphyte zone on the littoral areas after drainage.

The writer, however, thinks the biotic factors including inter-and intraspecific correlation are also effective for their community development. Moreover vegetation of the hydrospheric habitat has not completely become systematized ecologically though three community zones of the emergent, the floating-leaved and the submerged plants are recognized. Now the present writer made an attempt to analyse the communities of these three vegetation types more phytosociologically in detail, especially of amphiphyte zones, with reference to the life form system of dominants and their components. After adopting the life form spectrum method by Raunkiaer, he got such results as shown in Table 4.⁵⁾ As being apparent from this table, Hemi-

Table 4. The Life Form Spectrum in Each Type of Vegetation

Vegetation Type		The First Type	The Second Type	The Third Type
Life Form	Sample	Pond-Ama	Pond-Fuse	Pond-Ō
	M.G	7.2 %	2.3 %	0 %
	M.S	6.0	0	3.9
	M.C	10.9	4.5	11.5
	N	10.9	6.8	5.8
	CH	1.2	0	1.9
	H	27.7	31.8	32.7
	G	3.6	0	13.5
	H.D	2.4	18.2	0
	H.L	7.2	18.2	21.1
	Th.s	22.9	18.2	9.6
	Th.w	0	0	0
Number of spp.		83	44	52

cryptophytes are generally abundant in all these types. This fact proves that the vegetation in many fresh-water ecosystems tends to be alternated by Hemicrophyte communities with settling of sediments in the basins.¹⁴⁾ The table also indicates that each type is considerably different from others in the relative components of Hydrophytes, Helophytes and Therophytes; that is, Hydrophytes being most prevalent in the second, Helophytes prevalent in the third and Therophytes prevalent in the first type. Generally speaking the second type indicates the intermediate value between the first and the third. From these results, the vegetation seems to tend to change from the Therophyte type, which has less resistance ability, to the Helophyte type which is most adaptive for the environmental changes in hydric habitats.

The writer further made an attempt to analyse transitional vegetation of all components of each predominant community in the first and third type, especially the transitional constitution caused by the development of Helophytes and Therophytes. The following Figures 1 and 2 show the results of his analysis. From these figures it can be seen distinctly that the degree of development of Hydrophytes and

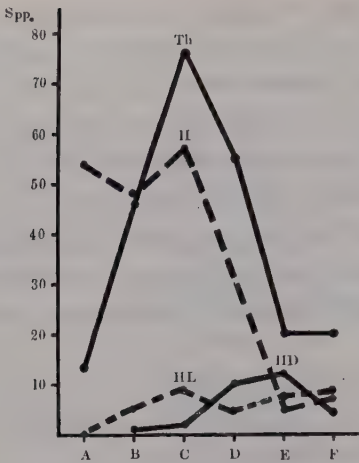


Fig. 1. The Life Form Spectrum of all Components Involved in each Predominant Community of the First Typal Vegetation (Pond-Kasumi)

- A: *Pleioblastus pygmaea* var. *glabra*
- B: *Dimeria ornithopoda* var. *tenera*
- C: *Lysimachia Fortunei*
- D: *Lobelia chinensis*
- E: *Eleocharis pelluchida*
- F: *Myriophyllum ussuriense*

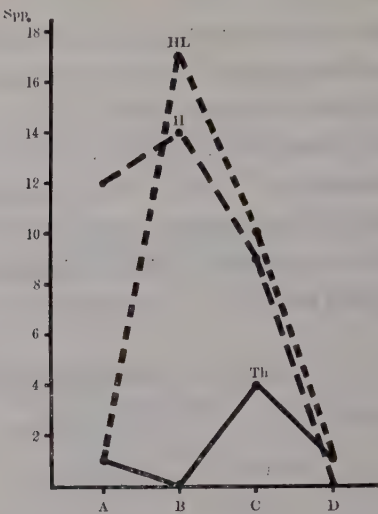


Fig. 2. The Life Form Spectrum of all Components Involved in each Predominant Community of the Third Typal Vegetation (Pond-Ō)

- A: *Miscanthus sinensis*
- B: *Phragmites communis*
- C: *Scirpus Preslii*
- D: *Eleocharis pellucida*

Therophytes has a remarkable diversity in these two types; that is to say, the amphiphyte zone of the first type which is occupied by *Dimeria*, *Lysimachia*, and *Lobelia* is invaded by abundant Therophytes, and that of the third type which is occupied by *Phragmites* and *Scirpus* has contrarily very poor Therophytes, although Helophytes are poor in the amphiphyte zone of the first type and are abundant in that of the third type.

Table 5. The Classification of Each Vegetation of the Three Types with reference to the Life Form Spectrum

Topogr. Type	The Marginal Part		The Littoral Part		The Central Part
	Zone of Phanerophytes	Zone of Hemicryptophytes	Zone of Hemicryptophytes	Zone of Therophytes	Zone of Hydrophytes
The First Type	Zone of Phanerophytes	Zone of Hemicryptophytes	Zone of Hemicryptophytes	Zone of Therophytes	Zone of Hydrophytes
The Second Type	Zone of Phanerophytes	Zone of Hemicryptophytes	Zone of Helophytes		Zone of Hydrophytes
The Third Type	Zone of Phanerophytes	Zone of Hemicryptophytes	Zone of Helophytes		

Consequently it will be noticeable that the amphiphyte zone is predominated by therophytic components in the first vegetation type, and is predominated by helophytic components in the third. He insists also that the interspecific correlation among the predominant communities is one of the most effective factors in the ecological succession in artificial reservoirs.

Then he classified the vegetations of reservoirs with reference to life form spectrum as shown in Table 5. He assumes that the preservation degree of Therophytes should be controlled by subterranean soil conditions and the interspecific correlation of germination of Therophytes and that of Helophytes. Consequently, the biotic control should be also important for the early stage of the community development, particularly of the amphiphyte zone development, after drainage in the artificial reservoirs.

Summary

1. The analytical studies were made to clarify the community structure after drainage, especially of the amphiphyte zone on the littoral areas. Three typical types of vegetation are recognized in about thirty artificial reservoirs, in Fukui, Shiga and Hiroshima Prefectures in Japan, whose basins are dried up in summer.

2. The first vegetation type indicates the regular zonal arrangement, and is characterized by the amphiphyte zone which is predominated by the annual plant communities. The second type exhibits the typical vegetation type, which is the intermediate structure between the first and the third, as usually found in many never-dried up pond vegetations, and its amphiphyte zone is occupied by the communities of both of the large- and the small-stemmed emergent plants. The third type shows the marshy vegetation, and it is most remarkable that its amphiphyte zone which is occupied by the communities of the large-stemmed emergent plants, especially by *Phragmites*, spread out over the central areas.

3. According to the analytical studies of life-form spectrum, Hemicryptophytes generally seem to be abundant in the basins of all three types. Besides, the amphiphyte zone of the first type indicates therophytic, of the second shows hydrophytic and of the third is helophytic type.

4. The components of Therophytes in each dominant community remarkably increase in the amphiphyte zone of the first vegetation type, though they decrease in those of the second type. On the contrary, the helophytic components are moderately poor in the amphiphyte zone of the first type though they are considerably abundant in the second and the third vegetation types.

5. The hydrarch which succeeded from the first to the second and ended in the third type will be illustrated in the vegetation among the three types of the artificial reservoirs.

6. The preservation of seeds of the annuals under the edaphic condition in winter, interspecific correlation between the germination ability of annuals, and the biotic control of Helophytes to annuals will be effective for the development of early stage of the community after drainage in the artificial reservoirs.

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Photoperiodic Induction in *Silene Armeria* as Influenced by Various Light Sources

by Atsushi TAKIMOTO*

滝本 敦*: 種々の光源によるムシトリナデシコの日長感応

Received July 8, 1957

I. Introduction. In the course of investigations on the flowering response of *Silene Armeria* to various combinations of light and dark periods (19), it was found that the light from the Mazda day-light fluorescent lamp of about 200 foot candles at the leaf surface can scarcely induce flowering, even when given continuously to the plant for ten days. However, incandescent light of 70 foot candle intensity at the leaf surface can readily induce flowering.

Hitherto, many investigations on the effect of intensity and wave length of light on photoperiodic induction have been made (2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 20). The action spectrum of the light required for "light break" (short exposure to light during the dark period which nullifies the induction effect of long dark period) in both short and long day plants was investigated in detail by Borthwick et al. (4, 5), and the highest efficiency of red light (ca. 6400 Å) was ascertained for both groups of plants. On the other hand, light conditions during the light period which requires relatively high light intensity (1, 11) remain to be examined

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in detail. Many workers who investigated influences of intensity and wave length of light on photoperiodic induction confined their studies to the supplemental light to lengthen the day light period, and analytical research on the high intensity light process has scarcely been performed. Recently, Stolwijk et al. reported some specific effect of wave length on flowering in a number of plants grown in light of restricted spectral regions (17, 18).

In the present investigations, lights of various lamps were examined for their photoperiodic efficiency in *Silene Armeria* with special reference to the high intensity light process. Artificial light was used exclusively.

II. Material and Methods. Material used, procedure of experimentation, equipment used for photoperiodic treatment and the precautions employed, were similar to those described, previously (19).

About one month after the treatment, plants were harvested and carefully examined for the initiation of flower primordia at the terminal buds, and developmental stages of flower primordia were recorded with the index numbers from 0 to 6 introduced previously by the present author (19). Stem lengths were also measured at the same time.

III. Effect of light of various lamps on flower initiation. Experiment 1. Plants were exposed for ten days to continuous light from various light sources.

Table 1. Flower initiation of *Silene Armeria* when exposed for ten days to continuous illumination of various lamps
(Sown on October 3, transplanted on December 23, treatment started on January 16, and dissected on February 25, 1952-1953)

Light sources	Intensity of light at the leaf surface in f. c.	No. of plants observed	No. of plants with flower	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
Natural day light supplemented with IL-60 at night	—	45	45	100	5.5	160.4
FL-20D × 3	200	48	2	4.2	0.1	9.2
FL-20pk × 3	130	47	40	85.1	2.0	43.3
IL-60	70	42	42	100	3.5	48.9
IL-20	30	45	40	88.9	2.2	55.3
FL-20D × 3 + IL-60	270	45	45	100	3.6	80.5
FL-20D × 3 + IL-20	230	32	32	100	3.3	38.5
FL-20D × 2 + FL-20pk + IL-20	210	47	47	100	3.5	55.0

IL-60: Mazda incandescent lamp of 60 watt.

IL-20: Mazda incandescent lamp of 20 watt.

FL-20D: Mazda day-light fluorescent lamp of 20 watt.

FL-20pk: Mazda pink fluorescent lamp of 20 watt.

FL-20D × 2 + FL-20pk + IL-20: Two FL-20D, one FL-20pk and one IL-20 were used together.

These abbreviations for light sources will be used hereafter.

The results are shown in Table 1. When FL-20D×3 was used for illumination, only 2 out of 48 plants initiated flower primordia, but when incandescent lamp (IL-20 or IL-60) was used, in spite of its low luminosity, many plants initiated flower primordia. In other similar experiments, which are not represented in the present paper, similar results were obtained. Light of FL-20D×2+FL-20pk+IL-20 was used in previous experiments (19) because of its high efficiency and low heat radiation.

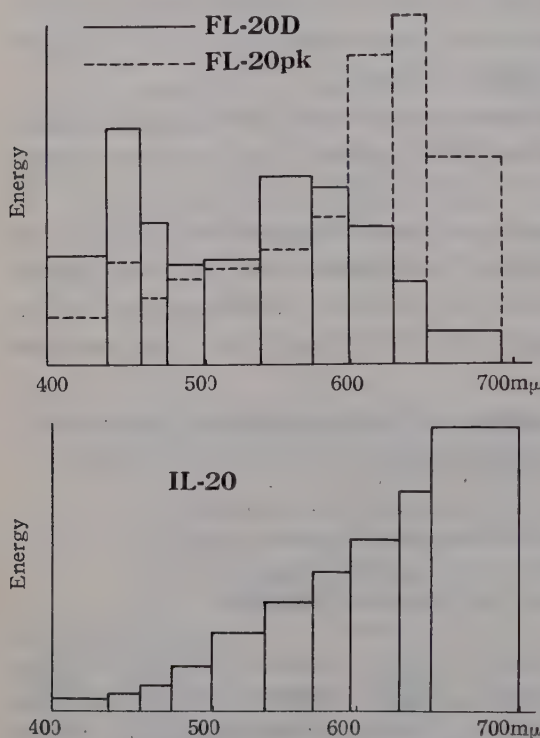


Fig. 1. Energy distribution spectrum of fluorescent lamps and incandescent lamp.

(After Tokyo Shibaura Electric Co. Ltd.)

lamp is inhibitory, or the flickering of light of fluorescent lamp is inhibitory to photoperiodic induction. The second alternative seems to be not probable because of the high efficiency of the light of FL-20D+IL-60 or FL-20D+IL-20 (Table 1). The third alternative is highly probable, since the flickering of FL-20D, FL-20pk and IL-60 (55%, 20% and 10%, respectively*) is inversely proportional to the percentage of flowering plants induced by the light of these lamps (4.2%, 85.1% and 100%, respectively). To investigate this possibility the following experiments were performed.

* Flickering of light is expressed as follows.

$$\text{Flickering(\%)} = \frac{(\text{max. light value}) - (\text{mean light value})}{(\text{mean light value})} \times 100$$

IV. Effect of intermittent light on the flower initiation. Experiment 2. Light of Mazda incandescent lamp of 60 watt was supplied intermittently with the use of stroboscopic filter. The intermittent frequency was adjusted to the flickering of light of fluorescent lamp (120 cycles/sec.) (Fig. 2).

Plants were exposed to this light for 10 days, and their flowering response was compared with those exposed to uninterrupted light of IL-60 with the same intensity at the leaf surfaces. Results are shown in Table 2. Between these two lots, no significant difference in their flowering response was found.

Experiment 3. Three FL-20D were used, each lamp being connected in different phase by the use of three-phase current. With this procedure, flickering of the combined fluorescent lamps was largely eliminated, becoming less (7%) than that

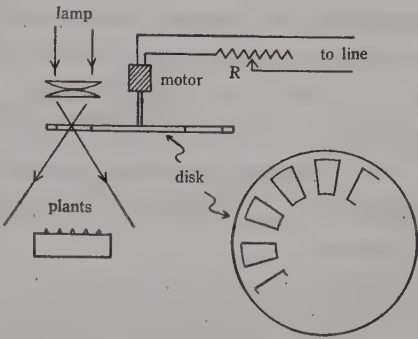


Fig. 2. Equipment used to interrupt the light of Mazda incandescent lamp of 60 watt.

Table 2. Effect of intermittent light on photoperiodic induction
(Sown on September 23, transplanted on November 19, experiment started on December 5 and dissected on January 8, 1953-1954)

Light conditions	Intensity of light at the leaf surface in f. c.	No. of plants observed	No. of plants with flower	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
Intermittent light of IL-60 (120 cycles/sec.)	30	45	13	28.9	0.7	13.5
Non-intermittent light of IL-60	30	46	18	39.1	0.7	15.1

Table 3. Effect of flickering of light on photoperiodic induction
(Sown on September 23, transplanted on November 19, experiment started on December 11, and dissected on January 19, 1953-1954)

Light conditions	Intensity of light at the leaf surface in f. c.	No. of plants observed	No. of plants with flower	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
FL-20D×3, each connected in different phase current. (Flickering 7%)	200	48	2	4.0	0.1	9.6
FL-20D×3, connected to single phase current. (Flickering 55%)	200	45	0	0	0	10.9
FL-20D×3+IL-60	270	45	45	100	4.4	80.5





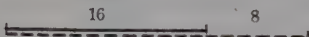


of the incandescent lamp (10%). Plants were exposed to this light for ten days and their flowering response was compared with the flowering response manifested by the control plants exposed to the light of three FL-20D connected in parallel to a single phase current. The results indicated no significant difference in flowering response between the two lots (Table 3). These results would exclude the third alternative above described, and the low efficiency of light of fluorescent lamp (FL-20D or FL-20pk) as compared with that of incandescent lamp may be due to the lack of longer wave lengths (longer than 6500 Å) which seem so effective in photoperiodic induction.




V. Flowering response induced by the light of FL-20D×2 supplemented with that of IL-20. Experiment 4. Plants were exposed to the following light conditions for 10 days:

- 1) Continuous illumination of FL-20D×2
- 2) Continuous illumination of IL-60
- 3) 16 hour light period of FL-20D×2+IL-60 followed by 8 hour dark period
- 4) 16 hour light period of IL-60 followed by 8 hour dark period.
- 5) Continuous illumination of FL-20D×2, supplemented daily with 16 hour illumination of IL-60
- 6) Continuous illumination of FL-20D×2 supplemented daily with 8 hour illumination of IL-60
- 7) 8 hour light period of FL-20D×2+IL-60 followed by 16 hour dark period

Table 4. Flowering responses of *Silene Armeria* when exposed to various light conditions for ten days.

(Sown on September 23; transplanted on November 25, experiment started on December 13, and dissected on January 22, 1953-1954)

Light conditions	No. of plants observed	No. of plants with flowers	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
1 	40	0	0	0	12.3
2 	45	45	100	2.6	55.3
3 	46	11	23.9	0.5	18.2
4 	46	7	15.2	0.2	14.0
5 	48	33	68.7	1.3	27.1
6 	47	7	14.9	0.2	21.2
7 	48	0	0	0	9.8

 Light of IL-60
 Light of FL-20D×2
 Darkness

The results are shown in Table 4. Light of FL-20D×2 did not induce flowering while that of IL-60 did. The light of IL-60 supplemented with FL-20D×2 was more effective in inducing flower initiation than that of IL-60 alone. That in the 5th lot a higher percentage of flowering plants is obtained than in the 3rd lot would mean that the light of day-light fluorescent lamp can suppress the inhibitory effect of darkness to some extent. Similar effect of FL-20D can be found when the flowering response of the 6th and the 7th lots is compared. It is also of interest that 8 hour

Table 5. Flowering responses of *Silene Armeria* when exposed to various light conditions for ten days.

(Sown on September 23, transplanted on November 10, experiment started on December 1 and dissected on January 11, 1953-1954)


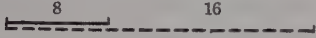




Light conditions	No. of plants observed	No. of plants with flowers	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
	20	8	40	0.8	21.4
	24	4	16.7	0.3	20.7
	20	0	0	0	11.2
	20	18	90	2.6	52.9
 Light of IL-20					
 Light of FL-20D×2					

Table 6. Flowering responses of *Silene Armeria* when exposed for 10 days to continuous illumination of FL-20D×2 supplemented daily with IL-20 of various durations.

(Sown on September 26, transplanted on October 30, treatment started on November 13 and dissected on December 26, 1955)

Supplemental light period in hours	No. of plants observed	No. of plants with flower	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
0	48	0	0	0	3.7
4	47	0	0	0	11.5
8	49	9	18.4	0.3	13.4
12	49	17	34.7	0.7	21.2
16	49	25	50.4	1.1	30.9
20	48	47	97.9	2.4	31.7
24	48	48	100	2.8	40.1

light period (less than the critical day length of this plant—10—12 hour (19) —) of IL-60 +FL-20D×2 can induce flowering if followed by 16 hour light period of FL-20D×2.

Experiment 5. In Experiment 5, treatments similar to those made for the 1st, 2nd, 5th and 6th lots of Experiment 4 were made using IL-20 instead of IL-60. Similar results to those of Experiment 4 were obtained (Table 5).

Experiment 6. In this experiment, plants were exposed to continuous illumination of FL-20D×2, and in addition 0, 4, 8, 12, 16, 20 and 24 hours light of IL-20 was given as a daily supplement. Table 6 shows the results.

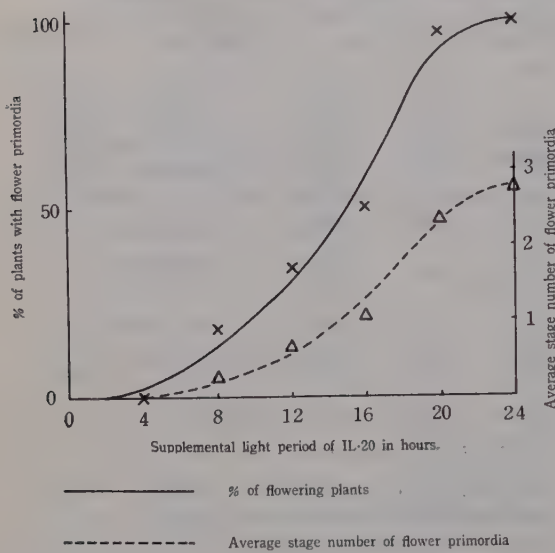


Fig. 3. Floral induction of *Silene Armeria* under continuous illumination of FL-20D×2 supplemented with daily illumination with various lengths of IL-20.

Supplemental 4 hour light of IL-20 did not induce flower but with the increasing duration of the light of IL-20, percentage of plants with flower primordia and average stage number of flower primordia increased showing sigmoid curves, respectively (Fig. 3).








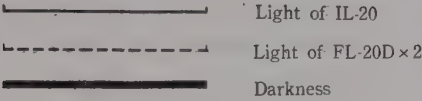
The question now arises whether the promotion of flowering by IL-20 is due to its nullifying effect of the inhibitory action of dark period, or it is due to a positive flower-promoting one. As has been described in Exp. 4 (Table 4), light of FL-20D ×2 seemed to nullify the dark effect to some extent, but it is also conceivable that

IL-20 acts more strongly. In the following experiments the effectiveness of these two light sources on the “light break” which is believed to nullify or diminish the inhibitory action of the dark period was examined.

VI. Effectiveness of FL-20D×2 and IL-20 in light break. Experiment 7. Plants were divided into three lots, two of which were exposed to an 11 hour photoperiod by the use of FL-20D×2+IL-20. In addition to this, the first lot was exposed to FL-20D×2, and the second to IL-20 each for 1 hour at the middle of the dark period. The third lot served as the control to which 12 hours of FL-20D×2+IL-20 and 12 hours of uninterrupted darkness were given. Quite similar “light break” effect was observed for FL-20D×2 and IL-20 (Table 7, Series I).

In another experiment the photoperiodic cycle consisted of 10 hour light followed by 14 hour darkness, and 1 hour “light break” was given 7 hours after the be-

Table 7. Light break effect of FL-20D×2 and IL-20.

Experi- mental series	Treatment	No. of plants observed	No. of plants with flowers	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
I		35	20	57.1	1.1	34.9
		35	20	57.1	1.3	41.3
		34	9	26.5	0.4	40.5
II		31	20	64.5	1.9	29.5
		27	22	81.0	2.5	24.2
		29	21	72.5	2.0	20.0
		33	0	0	0	17.1
						

ginning of the dark period. In this experiment, also, no significant difference in action between both kinds of light was observed (Table 7, Series II). Therefore, it may be concluded that the light of FL-20D×2 can suppress the flower inhibitory effect of dark period to the same extent as that of IL-20.

VII. Discussion. Light of FL-20D×3 can hardly induce flowering when supplied to the plants for ten days, whereas IL-20 can do so readily, and the former is as effective for a light break as the latter. Therefore, the flower-promoting effect of IL-20 may be considered to be a positive one, not a nullification of the inhibitory effect of the dark period.

Borthwick and Parker reported the highest efficiency of red light (ca. 6400 Å) as a "light break" in some long- and short-day plants (4,5). Light of FL-20D contains only a little red light but is effective for a light break to the same extent as that of IL-20, which contains abundant light of long wave length. As only a very low energy is required for the light break, sufficient energy must be contained in the light of FL-20D×2.

Light of FL-20pk contains abundant light of long wave length (6000-6500 Å) but is less effective than that of IL-60. It may be supposed that light of still longer wave length is more effective for flower induction (Exp. 1 and 2). Withrow and Benedict examined the photoperiodic efficiency of artificial light used to lengthen the day light period in *Viola tricolor*, *Matthiola incana* and *Callistephus chinensis* and concluded that the photoperiodic mechanism has a maximum spectral sensitivity in the vicinity

of 6500-7200 Å (20). Stolwijk et al. reported a positive photoperiodic effect of infra-red radiation in *Hyoscyamus* and *Cruciferae* (17,18). The same may also be true in *Silene Armeria*.

As has been reported in the previous paper (19), if the light period is shorter than 12 hours, flower initiation of *Silene Armeria* does not occur when the following dark period is continued for 14 hours or more, but if the light period is 14 hours or more, flower initiation occurs even when the following dark period is extended longer than 24 hours. A dark period continued for 14 hours or more may destroy the flower promoting effect of the preceding light period during which light of long wave length may be required. Assumingly flower-promoting effect established in a light period longer than 14 hours would be too stable to be destroyed readily by the subsequent long dark period.

In the present experiments, stem lengths were also estimated. A rather vague proportionality is seen between the stem elongation and the flower induction, but the relation is yet uncertain.

VIII. Summary. 1) The light of FL-20D (Mazda day-light fluorescent lamp of 20 watt) can hardly induce flower on *Silene Armeria* when supplied to the plant for 10 days. But the light of IL-20 (Mazda incandescent lamp of 20 watt) or the combination of FL-20D and IL-20 can readily induce flowering.

2) Flickering of light has no marked effect on the photoperiodic induction.

3) Light of FL-20pk (Mazda pink fluorescent lamp of 20 watt) which contains abundant light of 6000-6500 Å is less effective than that of incandescent lamp comprising abundant light of longer wave lengths.

4) If during the continuous illumination with FL-20D×2, additive illumination with various durations of IL-20 was supplied daily, flower initiation in percentage increased, following a sigmoid curve, with the increasing duration of supplemental illumination.

5) Light of both FL-20D×2 and IL-20 shows the same effect when used as a light break.

6) It is concluded that the light of IL-20 with its higher content of longer wave lengths would have a positive flower-promoting effect and that the lower effectiveness of the light of FL-20D may be due to the lack of light of long wave length.

Grateful acknowledgment is made to Professor S. Imamura and Professor A. W. Galston for their suggestions and criticisms.

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Two Processes Involved in the Light Period of Inductive Photoperiodic Cycles in *Silene Armeria**

Atsushi TAKIMOTO**

滝本 敦**: ムシトリナデシコの開花を促進する光週期の明期における二つの段階*

Received July 12, 1957

As has been reported in a previous paper (5), *Silene Armeria* is scarcely induced to flower when exposed continuously to the light of day-light fluorescent lamp for ten days at the luminosity of about 200 foot candles at the leaf surfaces; but induced readily by the light of incandescent lamp of 30-70 foot candles. Eight hour illumination from the day-light fluorescent lamps supplemented with the incandescent lamp is insufficient for flower initiation when followed by 16 hour dark period (5), but it is sufficient when followed by 16 hour light of day-light fluorescent lamp which has little inductive effect in itself. In those experiments, photoperiodic treatment was continued for ten days or more, accordingly, it is also conceivable that the 8 hour light of day-light fluorescent lamp plus incandescent lamp preceded by the 16 hour light of day-light fluorescent lamp will be the inductive cyclic unit.

The present investigation was done to determine whether the 8 hour light period of supplemental incandescent lamp followed or preceded by illumination from the day-light fluorescent lamp is an effective cyclic unit for flower initiation.

Material and Methods

Materials, procedure of experimentation and the precautions employed were the same as those described in previous papers (4, 5). The energy distribution of the

* 文部省科学研究助成金による研究

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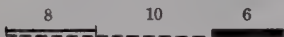
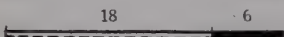

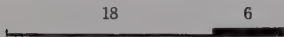
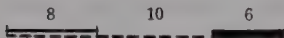

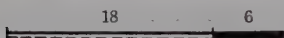



lamps used in the present investigation was also described in the previous paper (5). In every case, two Mazda day-light fluorescent lamps of 20 watt (FL-20D×2; 140 f. c. at the leaf surfaces) and/or Mazda incandescent lamp of 20 watt (IL-20; 30 f. c. at the leaf surfaces) were used as the light sources.

Experimental Results

I: Flowering responses under 18 hour photoperiod of FL-20D×2 supplemented with IL-20 during the first or the last 8 hours of light period.

Experiment 1. Three lots of plants were exposed to long days consisting of 18 hour light period of FL-20D×2 and 6 hour dark period for 12 days. The first and second lots were supplemented with the light of IL-20 during the first and the last 8 hours of light period respectively. The third lot was supplemented with the incandescent lamp throughout the light period.

Table 1. Flowering responses of *Silene Armeria* under 18 hour photoperiod of FL-20D×2 supplemented with the light of IL-20 during the first or the last 8 hours of light period.

Treatment		No. of plants observed	No. of plants with flowers	% of plants with flowers	Average stage number of flower primordia	Average length of stems in mm
Exp. 1		32	32	100	3.3	63.2
		34	19	50.2	1.4	50.2
		34	34	100	3.6	70.7
Exp. 2		70	0	0	0	8.1
		68	3	4.4	0.1	13.2
		65	0	0	0	8.7
		70	16	22.8	0.4	15.1
		69	51	73.9	1.4	31.1
		Light of FL-20D×2				
		Light of IL-20				
		Darkness				

Results are shown in Table 1 (Exp. 1). In the first and the third lots, all plants initiated flower primordia but in the second lot, in which the supplementary light was given during the first 8 hours, only 19 out of 34 plants initiated flower primordia. It is evident that the supplementary light of IL-20 is more favorable for flower induction when given in the last than in the first 8 hours of light period. This

phenomenon will be more clearly indicated in the following experiment.

Experiment 2. Five lots of plants were subjected to 18 hour light period followed by 6 hour dark period for 14 days. Light sources used in each lot were as follows: 1) FL-20D×2, 2) IL-20, 3) FL-20D×2 supplemented with IL-20 during the first 8 hours of light period, 4) FL-20D×2 supplemented with IL-20 during the last 8 hours of light period, 5) FL-20D×2+IL-20 (Table 1, Exp. 2).



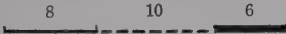
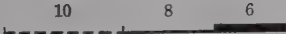
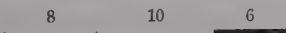
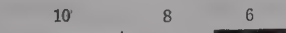
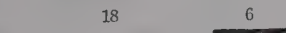
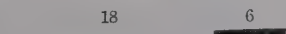
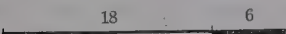



Plants of the third lot did not initiate flower primordia but 16 out of 70 plants in the fourth lot initiated. Plants exposed to the light of FL-20D×2 could not be induced to flower, while 3 out of 68 plants exposed to the light of IL-20 and 51 out of 69 plants exposed to the light of FL-20D×2+IL-20 were induced respectively.

From these experiments, it is supposed that light process may be divided into two partial processes, one of which is favored by the light of incandescent lamp which comprises abundant light of long wave lengths, and must be preceded by another one which proceeds favorably under the light of FL-20D×2.

If this is ture, similar results will be obtained when the light of FL-20D×2 is switched off during the supplemental light period of IL-20. This possibility was examined.

II: Flowering responses under 18 hour photoperiod consisting of 8 hour light period of IL-20 followed or preceded by 10 hour light period of FL-20D×2.

Table 2. Flowering responses under 18 hour photoperiod consisting of 8 hour light period of IL-20 followed or preceded by 10 hour light period of FL-20D×2.

Treatment		No. of plants observed	No. of plants with flowers	% of flowering plants	Average stage number of flower primordia	Average length of stems in mm
Exp. 3		32	0	0	0	14.0
		34	33	97.1	2.5	37.2
		33	1	3.0	0.0	14.9
		30	23	76.7	0.8	25.1
Exp. 4		30	10	33.3	0.8	23.0
		27	18	66.7	1.5	36.1
		28	0	0	0	20.1
		30	12	40.0	1.0	24.1
		29	29	100	2.3	42.2
		Light of FL-20D×2				
		Light of IL-20				
		Darkness				

Experiment 3. Four lots of plants were subjected to 18 hour light period followed by 6 hour dark period for 14 days. Lamps used for illumination were: 1) FL-20D \times 2, 2) FL-20D \times 2+IL-20, 3) IL-20 of 8 hours followed by FL-20D \times 2 of 10 hours, 4) FL-20D \times 2 of 10 hours followed by IL-20 of 8 hours.

Twenty-three out of 30 plants subjected to the light of IL-20 after illumination of FL-20D \times 2 initiated flower primordia, but only 1 out of 33 plants flowered when exposed to the light of the same sources in reversed order (Table 2, Exp. 3).

Experiment 4. A similar experiment but with one additional lot which was exposed to 18 hour light period of IL-20 followed by 6 hour dark period, was repeated, and similar results were obtained (Table 2, Exp. 4).

In this experiment, the lot exposed to the 18 hour light period of IL-20 showed less flower initiation (flowering plants, 40%) than the lot exposed to 10 hour illumination of FL-20D \times 2 followed by 8 hour illumination of IL-20 (flowering plants, 66.7%). Although the difference observed in this case was rather small, it was clearly confirmed in the following experiments.

Table 3. Flowering responses of *Silene Armeria* under 18 hour photoperiod, consisting of various light periods of FL-20D \times 2 followed by supplemental light period of IL-20.

Treatment		No. of plants observed	No. of plants with flowers	% of plants with flowers	Average stage number of flower primordia	Average length of stems in mm
Exp. 5		35	5	14.3	0.1	22.2
		35	32	91.5	1.2	28.0
		35	32	91.5	1.0	27.5
		35	0	0	0	14.0
		34	22	64.7	0.7	26.1
		28	28	100	1.8	33.3
Exp. 6		34	10	29.4	0.2	31.6
		35	30	85.8	2.3	33.3
		35	33	94.2	2.5	36.1
		33	19	57.6	1.2	32.7
		Light of FL-20D \times 2				
		Light of IL-20				
		Darkness				

III: Flowering responses under 18 hour photoperiod consisting of various light periods of FL-20D \times 2 and IL-20.

Experiment 5. Plants were subjected to 18 hour light period followed by 6 hour darkness for 13 days, the light period being divided into two periods using FL-20D \times 2 and IL-20. In three experimental lots the light of FL-20D \times 2 was followed by that of IL-20 of various durations, that is, 1) 14 hour light period of FL-20D \times 2 followed by 4 hour light period of IL-20, 2) 9 hour light period of FL-20D \times 2 followed by 9 hour light period of IL-20, 3) 4 hour light period of FL-20D \times 2 followed by 14 hour light period of IL-20. Three control lots were subjected to 18 hour light period of FL-20D \times 2, IL-20 and FL-20D \times 2+IL-20 respectively (Table 3 Exp. 5).

The plants subjected to the light of IL-20 for 4, 9 and 14 hours preceded by 14, 9 and 4 hours of illumination with FL-20D \times 2 initiated flower primordia on 14.3, 91.5 and 91.5% of the plants respectively. Out of the plants subjected to 18 hour light period of IL-20 followed by 6 hour dark period 64.7% of them initiated flower primordia. In another experiment, similar results were obtained as shown in Table 3, Exp. 6.

When the light period of FL-20D \times 2 was followed by that of IL-20, relatively longer periods of the latter seem to be favorable for the flower initiation.

The lot subjected to the 18 hour light period of IL-20 was induced to flower significantly less than the lots exposed to 9 or 4 hour light period of FL-20D \times 2 followed by 9 or 14 hour light period of IL-20, respectively (cf. II, Exp. 4), suggesting that the light period comprises two separate processes; the first process proceeds more readily under the light of FL-20D \times 2 than under that of IL-20, and the other, the second process, is favored by the light of IL-20.

Discussion

Experiments reported in the previous paper (5) show that the flower promoting effect of the light of incandescent lamp which comprises abundant light of long wave lengths, is a positive one, that is, the light does not act by removing the inhibitory effect of darkness but by bringing about a stimulative effect for flower initiation. In the present experiments the light of an incandescent lamp was found to be more effective when preceded by the light of FL-20D \times 2 than when followed by it.

The separation of the light process into two partial processes seems to be reasonable. The first process seems to require relatively high intensity light and effectuate the following second process which seems to give rise to a positive flower promoting effect and requires the light of relatively long wave length.

Both of these light processes are considered to differ from so called "low intensity light process" (1, 2, 3) which nullify or diminish the dark reaction, since the light of incandescent lamp and that of day-light fluorescent lamp are equally effective for light break (5), whereas, as seen above, they act in so different ways in the above mentioned two light processes.

In the present paper emphasis was laid on the positive flower promoting effect of light, but the flower inhibitory effect of dark period must also be taken into consideration for elucidating the photoperiodic response of this plants (4). The extent of inhibition of the dark period may be different according to the light sources preceding it. From the present and other preliminary experiments, it appears that the dark period preceded by the light of FL-20D \times 2 is more inhibitory for flower induction than that preceded by the light of IL-20.

By the way, light of day-light fluorescent lamp seems to be a good light source for photosynthetic process, and the first process above mentioned is supposed to be related to photosynthesis.

Summary

Silene Armeria can hardly be induced to flower when exposed to 18 hour light period of Mazda day-light fluorescent lamp of 20 watt (FL-20D) for 14 days, but can readily initiate flower primordia if an 8 hour light of incandescent lamp of 20 watt (IL-20) is supplemented daily. The supplementary light of IL-20 is given more effectively in the last than in the first 8 hours of light period.

The 18 hour light period is given as a combination of 8 hours of IL-20 and subsequent 10 hours of FL-20D. An illumination sequence: FL-20D \rightarrow IL-20 is more favorable for flower initiation than the reversed one.

The FL-20D treatment followed by the IL-20 appears to be more favorable for flower initiation than the IL-20 alone.

From the above facts, the flower promoting light period is postulated to be separated into two processes, one of which proceeds favorably under the light of day-light fluorescent lamp and effectuates the following process which gives rise to a flower promoting effect and is favored by the light of incandescent lamp comprising abundant light of long wave length (longer than 6500 Å).

The author wishes to express his best thanks to Prof. S. Imamura and Dr. A. W. Galston for their valuable suggestions and criticisms.

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On the Mating Reaction of a *Chlamydomonas*, with Special References to Clumping and Chemotaxis*

by Yoshihiro Tsubo**

坪 由宏**: クラミドモナスの接合反応, 特に群形成と走化性について*

Received July 19, 1957

In the course of the study on the sexual reproduction of a unicellular green alga, *Chlamydomonas* sp. 24 which was isolated by the present author, this organism was found to have some different sexual behaviour than those which have been reported in other species. The present species is isogamous and heterothallic; complementary mating types have been arbitrarily designated as "plus" and "minus", and its morphology has already been described (23). The following observations specifically relate to clump-formation and chemotaxis in the initial mating reaction of *Chlamydomonas* sp. 24.

Methods

a) Cultivation of the organism

Sexually active gametes of *Chlamydomonas* sp. 24 can be obtained by the following cultivation. The method of the early report (23) was modified by a personal suggestion from Dr. Franz Moewus. Though not all the following method is just the same with his own, yet it seems to be better than the one described before in this species to get almost synchronous culture with sexually active gametes.

Vegetative cells of each mating type are separately grown on the agar slants of the following medium MAC.

Medium MAC contains per liter of dist. water;

NH ₄ NO ₃	0.25 g	Microelements;	
MgSO ₄ ·7H ₂ O	0.175 g	H ₃ BO ₃	1 mg
KH ₂ PO ₄	0.175 g	ZnSO ₄ ·7H ₂ O	1 mg
K ₂ HPO ₄	0.075 g	MnCl ₂ ·4H ₂ O	0.4 mg
CaCl ₂ ·2H ₂ O	0.05 g	CoCl ₂ ·6H ₂ O	0.2 mg
NaCl	0.025 g	H ₃ PO ₃ ·12MoO ₃ ·6H ₂ O	0.2 mg
Fe(NH ₄) ₂ H(C ₆ H ₅ O ₇) ₂	0.01 g	CuSO ₄ ·5H ₂ O	0.04 mg
Sodium Citrate	0.5 g		
Sodium Acetate.....	1 g		

MAC-Agar is prepared with 1% Agar.

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At the beginning of the experiment, the cultures were transferred into water to make dense suspension. After almost all the cells became motile, each three drops of a single mating type were spread over widely on MAC-Agar plate. Cultivation was continued for 10-14 days under constant illumination from fluorescent tubes (white-light, ca. 4000 lux) at ca. 23°C. At the end of this period the cultures were flooded with the medium MA-N which is described below.

Medium MA-N contains per liter of dist. water;

MgSO ₄ ·7H ₂ O	0.175 g	NaCl	0.025 g
KH ₂ PO ₄	0.175 g	FeSO ₄ ·7H ₂ O	0.01 g
K ₂ HPO ₄	0.075 g	Sodium Acetate.....	0.5 g
CaCl ₂ ·2H ₂ O.....	0.05 g	Microelements; all the same with MAC	

Then they were carried into the dark and kept there for about 16 hours at ca. 23° C. Many sexually active gametes were gained by removing the dark culture to the light and illuminating them for 30 minutes or so.

b) Vital staining

As similar as some other *Chlamydomonas*, this species is also isogamous and heterothallic, the two mating types are morphologically indistinguishable each other. So that it was necessary to make an indicator in order to see the difference of sexual behaviour between each mating type. The method of vital staining was used: Neutral red was prepared at a concentration of 40 mg in one liter of MA-N medium, and was provided to the culture before the dark period started. Vitrally stained cells always carried red marked particles, presumably of volutin granules, in the protoplasm (Pl. I-E, F). The motility or the sexual activity is thought not to be injured by the treatment. This dye is quite beneficial to apply in such a work: Lewin (9) also used it as an indicator for another purpose and reported the same concentration had no appreciable effect on the growth of *Chl. moewusii*.

c) Chemotaxis

Pfeffer's capillary method (17) was used, capillary tubes were prepared as to have a diameter of 1/4 or 1/5 mm and at one end closed. Test material could easily be replaced with the air in the capillary by suctioning out the air from the tube. Then the tube was placed into algal population on a slide glass. Observations were made under microscope in the laboratory conditions.

Results

a) Clumping and pairing

In a single culture either of plus or minus mating type, each individual gametes are only propelling in random directions (Pl. I-A). When dense suspensions of two mating types are mixed, clearly remarkable clumps composed of much more cells are built up in a few minutes (Pl. I-B) as have been realized in lots of *Chlamydomonas* species (2, 3, 8, 13, 20). Within a clump it looks as if they were hitting each other with their flagella. But in the sparsely populated culture the cells associate in smaller

clumps as has been observed in other species (8,13). By continuous observation, it was found that a single cluster could produce more than one couple of the gametes (Pl. I-C). In a short time of their recurring acute hitting each at flagella, the two copulants become to fuse and be linked tightly together by a thin protoplasmic bridge at their anterior ends where flagella are originated (Fig. 1).

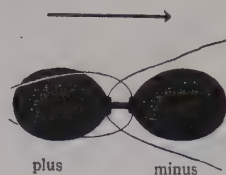


Fig. 1. Mating pair and its motility direction

Once a mating pair is formed it remains still its motility for about few hours until the flagella are withdrawn; during this period it does not move forward and backward, but only in one direction as was the case of an individual cell. This was just as like as reported by Lewin (7,11) in *Chl. moewusii*; only the one partner of the copulants which has been designated as "plus" remains to beat its flagella and is responsible to the propulsion of the mating pair. The minus partner is then always being carried backward. Such a difference of behaviour in the motility was noticed in the present study by making copulation between vitally stained plus and non-stained minus, and vice versa (Fig. 1 & Pl. I-F).

Hutner and Provasoli (6) described the clumping occurred between cells killed by gentle heating or other agents and living cells of opposite mating type. Such was found also in the present species: Similar clumps are built between the plus cells killed by osmium vapour and alive minus cells, and also in the reciprocal case (Pl. I-D,E). Now in this case, however, yielding no mating pair, the cluster collapses gradually, and each cell is released in time. Therefore the accomplishment of real pairing would be a further separate step.

b) Chemotaxis

As mentioned above, clumping was realized to occur in this species between dead cells and living ones of the complementary mating type, further experiment was designed to examine a hormonal mechanism such as has already been described by Moewus (15) with *Chl. eugametos*.

Cell free filtrate of the culture is get ready by centrifugation and filled up in a capillary tube. Among all the combinations which were tested, the characteristic of positive chemotaxis took place solely in one case, i. e. plus cells are definitely attracted to the filtrate of minus culture (Fig. 2-C & Pl. II-B,C).

But in contrast, no appreciable change occurred in the case of minus gametes to the filtrate of plus culture (Fig. 2-b & Pl. II-A). Apparently the minus gametes exclusively secrete chemotactic agent in the medium.

Although the secretion from the plus cell appeared to be negative, preliminary

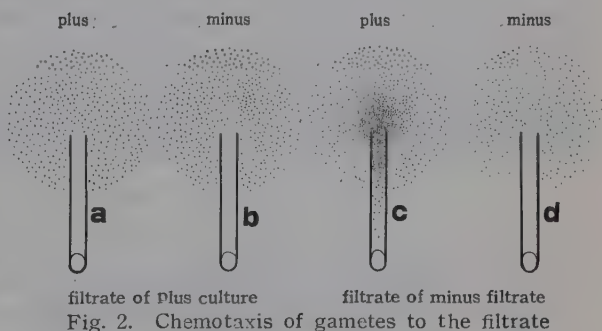


Fig. 2. Chemotaxis of gametes to the filtrate

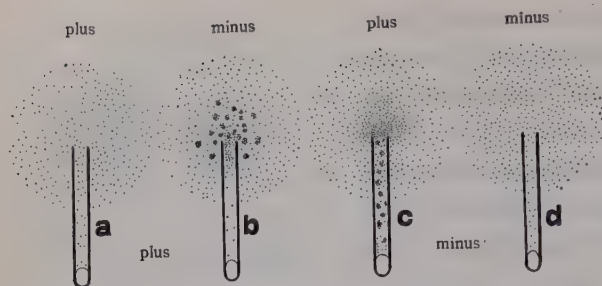


Fig. 3. Interaction between alive plus and minus gametes

tions between both living gametes are drawn in Fig. 3. When a capillary which contains alive minus cells is placed into the plus culture, the plus gametes are chemotactically gathered to the mouth of the tube and enter it, then they make clumps with the minus cells inside the tube (Fig. 3-c & Pl. II-D,E). The minus cells do not noticeably pass out of the tube. But in the reciprocal case, the plus gametes actively swim out of the tube and make clumps outside where minus gametes are swimming (Fig. 3-b & Pl. II-F). Places where clumps are built are quite distinctive in the two cases.

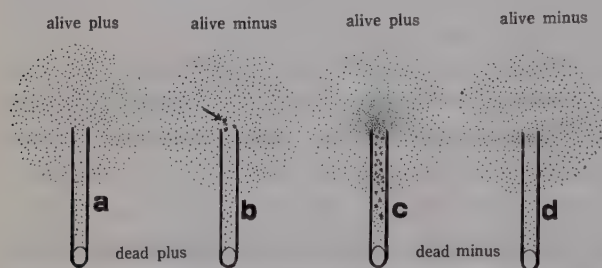


Fig. 4. Interaction between alive and dead gametes (I)

Pl. III-A). But if a capillary containing dead plus is placed into the alive minus, no or occasionally little clumping occurs only at the mouth part of the tube (Fig. 4-b & Pl. III-B). This would involve no chemotactic mechanism. Such little clumping would be caused merely by the random contact and adhesion or by something like thigmotaxis of swimming minus cells to the plus ones which were thrown out of the

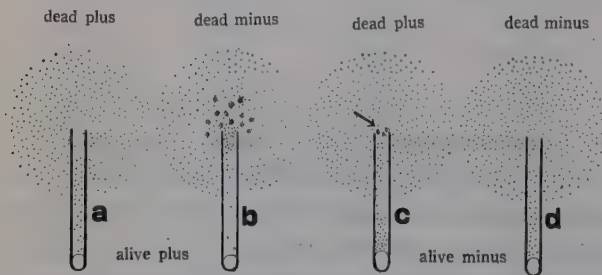


Fig. 5. Interaction between alive and dead gametes (II)

observation recorded the occurrence of clumping between dead plus and alive minus cells. Therefore it was necessary to see the relation between clumping and chemotaxis. In the following experimental series, capillary tubes were filled with living or killed cells.

At the first place, the rela-

In Fig. 4 and Fig. 5, further relations between alive and killed gametes are drawn. When a capillary which contains dead minus gametes is placed into alive plus culture, the latter gametes chemotactically enter the tube and clumps are built up inside the tube (Fig. 4-c & Pl. III-A). As has been assumed by Hutner and Provasoli (6), an idea of some "surface-active" reaction would be involved here in this case.

In the last part of the experiment, capillary tubes were filled up with alive gametes. When a capillary which contains plus

cells is placed into a drop of dead minus cells, the plus gametes actively swim out and clumping occurs outside the tube (Fig. 5-b & Pl. III-C,D). In the other case (Fig. 5-c) the swimming minus cells do not easily come out from the tube. But in this case also, no or timely little clumps are formed at the mouth part of the tube. The same concept just described above would be applied to the mechanism concerning such a poor clump-formation.

Discussion

In the study of sexual processes of *Chlamydomonas* sp. 24, evidence of chemotaxis was noticed in the initial mating reaction. One of the mating type designated as "minus" secretes some sex substance in the medium to which the "plus" cells are definitely attracted. The reverse, however, was not the same. Although the chemical nature of the substance is yet uncertain, such a chemotactic mechanism should have an important role in the mating reaction in this *Chlamydomonas*.

There are hitherto two distinctive views concerning the character of sex substance with *Chlamydomonas*. Several sex substances of *Chl. eugametos* reported by Moewus (15) had the diffusible nature from the cell and either filtrate of male or female culture was mutually responsible to attract the opposite sex. And the chemical nature of the agent was identified as to be the natural gamone, the proportional

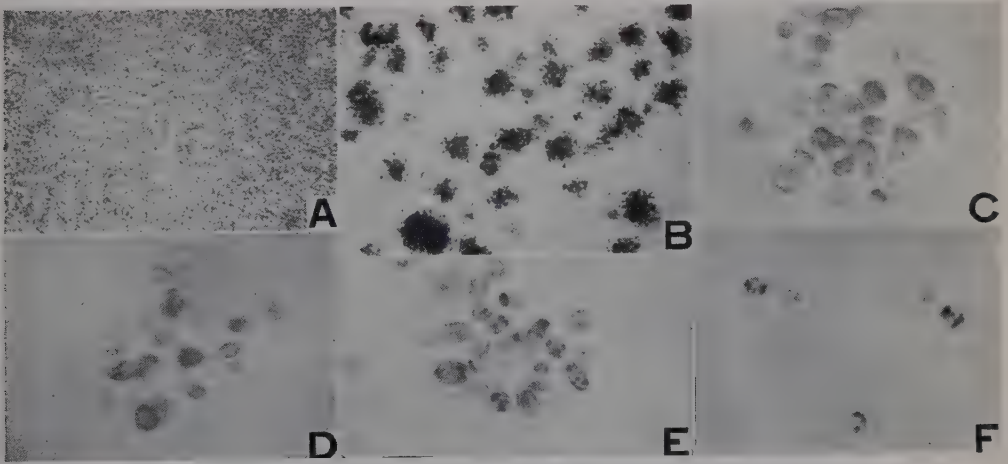
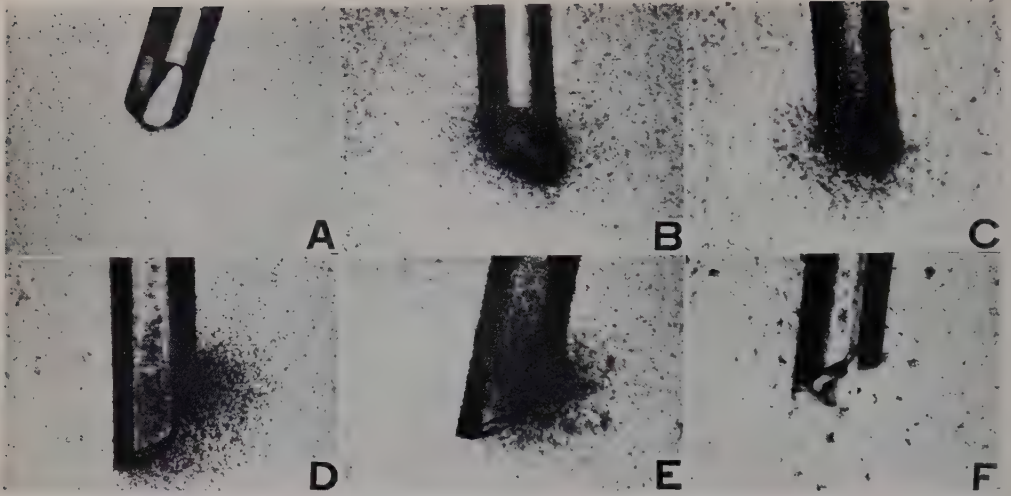
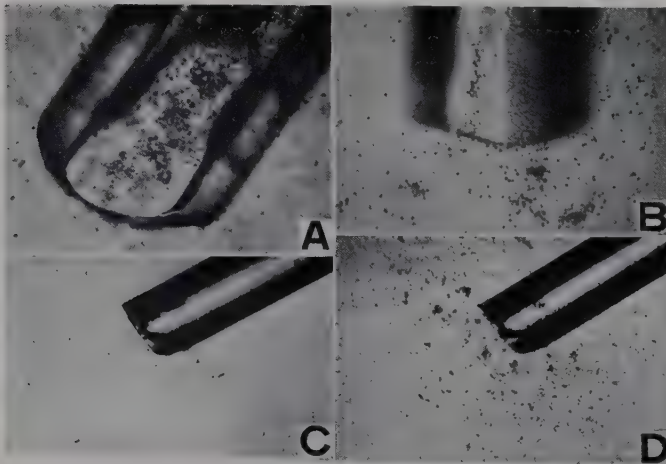


Plate I. A. Gamete suspension of a single mating type (plus gametes).
 B. Clump-formation, few minutes after the mixing of plus and minus gametes.
 C. Single clump enlarged, several mating pairs are being liberated.
 D. Clump which was produced between dead minus and living plus gametes.
 E. Clum which was produced between dead plus and living minus gametes. The minus cells are marked with neutral red (The marker are shown as black particules in a cell).
 F. Mating pairs (both cells are living) produced between plus and marked minus gametes.



- Plate II.
- A. Minus gametes do not show any reaction to the filtrate of plus culture.
 - B. Plus gametes are positively attracted to the filtrate of minus culture.
 - C. Same with B., few minutes later.
 - D. Plus gametes are actively entering the tube which contains living minus gametes, and clumping occurs between them.
 - E. Same with D., few minutes, later.
 - F. Plus gametes which have been inside the tube come out and make clumps with the living minus cells outside the tube.



- Plate III.
- A. Living plus gametes enter the tube and produce clumps with dead minus cells inside the tube.
 - B. Minus gametes keep swimming outside the tube in which dead plus cells are contained. Little clumps are formed between the minus and the plus cells which are thrown out of the tube.
 - C. Living plus cells are swimming out from the tube and into the field where dead minus cells are scattered.
 - D. A few minutes after the stage shown C. Clumps are being formed in the outfield.

mixtures of cis- and trans-dimethyl crocetin (14). Despite the Moewus' report, however, Förster et al. (4) could find neither crocin nor crocetin in the culture of Moewus' *Chl. eugametos*. But they found a separate gamone in the filtrate which had another function referring to the intracolonial clumping both with *Chl. eugametos* (2, 4) and *Chl. reinhardi* (3).

In contrast to these works, the case reported on *Chl. moewusii* is quite different (6, 12). Hutner and Provasoli (6) examined about the clumping in the species, but all of their attempts to show diffusible sex substance were unsuccessful. But as clumping occurred mutually between killed and living opposite sex, they had a view that the initial clumping was to occur by the reaction of surface-active such as being induced by random contact rather than diffusible substance. Lewin (10, 12) postulated in the study of sexual behaviour of the same species, that there was certain intracellular hormone responsible for the sexual activity; he assumed it to be formed within the cell and pass some stimulation into the flagella. And he considered this sex substance of *Chl. moewusii* to be non-diffusible.

According to the observations with *Chl.* sp. 24, really the actual contact of the cells each other would be the definite reaction to make clumps, and the action at flagella was quite suggestive to assume that certain adhesive mechanism would localize to this organelle. However, also the chemotactic attraction beyond long distance would have a prior important role to allow them coming nearer. But it remains yet to be shown whether or not both of the attractive and adhesive mechanism are to depend on the same origination.

There have been many attempts to study the sexual processes of the Thallophytes on a level of sex substance (5, 18, 21, 22). The concept of the chemotactic response of antherozoids to the archegonium has widely been distributed among ferns and mosses (19, 24). However in algae, besides some descriptions on *Chlamydomonas* (14, 16), two experiments clearly indicate the chemotactic attraction of spermatozooids to the filtrate of eggs respectively in *Sphaeroplea* (16), and *Fucus serratus* and *F. vesiculosus* (1). Judging from the chemotactic behaviour of the two mating types and also from the movement of the mating pairs, the present species shows clear sexual differentiation between each mating type, even though they are morphologically quite similar and both of them are motile. The "plus" cells appear to act as like as male, and the "minus" female.

The present author wishes to express his hearty thanks to Dr. F. Moewus for his kind suggestion on the cultivation of this organism, and to Prof. H. Hirose of Kobe University for giving the continuous encouragement and the criticism to the manuscript.

Summary

1. *Chlamydomonas* sp. 24 which is heterothallic and morphologically isogamous, shows remarkable differentiation in its sexual behaviour between each mating type.

2. One of the mating types which has been designated as "plus" acts as male and is chemotactically attracted beyond long distance to the filtrate or the gametes of the "minus" mating type. But the reverse was not at all the same. However finally the flagella of both gametes seem to have some similar adhesive mechanism in the clump-formation. The nature of the chemotactic agent is yet uncertain.

3. Once the two capulants were linked together by a protoplasmic bridge, only the "plus" partner was responsible to the propulsion of the mating pair. The motility direction is limited only in one direction as was observed in *Chlamydomonas moewusii* (7).

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帽菌類の diploidisation における核の行動

I. 不和合性組合わせの場合*

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Hymenomycetous Fungi I. Illegitimate Combinations*

1957 年 7 月 12 日受付

前 書 き

四極性の帽菌類で一つの交配型、例えば AB の単相大菌叢の周縁の一部に接して $Ab+aB$ のような、どちらの核も AB 核と和合できない不和合性複相菌糸を植えた場合でも diploidisation が起り、AB 菌叢の周縁部に新しく複相菌糸が現われて来る。しかし、 $AB+ab$ のような和合性、又は $ab+A'B'$ のような両和合性の複相菌糸を接種した場合に較べて diploidisation の進行が遅れ、しかも周縁部の複相菌糸の現われ方が局部的で、いわゆる patchiness を示すものである。以上のことは Buller (1931), Chow (1934), Dickson (1936), Quintanilha (1938, 1939), 及川 (1939), 川村 (1941), Papazian (1954) 及び著者 (1954a) 等によって等しく観察されたところである。そして $Ab+aB$ によって diploidisation を起した AB 菌叢の周縁部の新複相菌糸の一部をとって培養して子実体を作らせ、それからの単孢子培養菌糸を標準菌糸と組合わせ培養して交配型分析をした結果は、新複相菌糸の不和合性因子の構成が $AaBb$ であり、決して $AABb$ でも $AaBB$ でもないことを示すものである (Buller (1931), 川村 (1941), 木村 (1954))。

上記の事から推論して Rawitscher (1933) は AB に $Ab+aB$ を接種するような不和合性組合

わせ (以下 $AB \times (Ab+aB)$ のように記することにする) による diploidisation においては、接種した複相菌糸の Ab, aB の 2 核がどちらも AB 菌叢中を移行して、その周縁部に到達したら、AB 核をさし置いて Ab, aB の 2 核で複相菌糸を新生するものであると述べ、この説は Buller (1933), Chow (1934), Dickson (1936), 及川 (1939) 等の支持を得た。一方 Quintanilha (1939) は別の解釈を下し、AB 菌叢に接して $Ab+aB$ を植えると不和合性組合わせなるが故に Ab, aB の 2 核の核分裂の際、A 因子の乗っている染色体と a 因子の乗っている染色体の交換が 2 核の間で起り、その結果 AB, ab の 2 核が新しく生じ、この中の ab 核が AB 菌叢の中を分裂しながら移行して周縁に達し、AB と ab の 2 核で複相菌糸を作っていくものであるとした。なお、四極性のものでは多くの場合、A 因子と B 因子とは連鎖していない (Whitehouse (1949), 木村 (1952)) ことを附言しておく。

Papazian (1950, 1954) は *Schizophyllum commune* を用いて diploidisation の研究を行い、単相大菌叢の周縁部に新生した複相菌糸の 2 核を、子実体の形成を不要とする独特の方法で推定した。そして不和合性組合わせによる diploidisation の実験では、Rawitscher の 2 核移行説を裏書きする結果を得ると同時に Quintanilha の説のような新核形成の場合をも見ている。

著者は帽菌類の不和合性、和合性、両和合性の各組合わせによる diploidisation で、接種した複相菌糸の 2 核の行動について研究中であるが、本号においては不和合性組合わせの場合について調べたところを報告する。

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材料と方法

四極性のウシグソヒトヨ *Coprinus macrorrhizus* Rea f. *microsporus* Hongo を実験に供した。しかし、一つの系統だけを用いて不和合性組合わせの diploidisation の実験を行っては、Rawitscher の2核移行説、Quintanilha の染色体交換説のどちらが正しいかを定めることはできない。それは単相大菌叢の周縁部に出現した複相菌糸の2核の推定は、前書きで述べたように、この複相菌糸を一部とって培養し、生じた子実体から分離した単胞子培養菌糸の交配型分析の結果によるのであるから、 $AB \times (Ab + aB)$ の場合、周縁部に現われた複相菌糸の核の構成が2核移行説の $Ab + aB$ であっても、また染色体交換説の $AB + ab$ であっても、この複相菌糸が子実体を作り、その担子柄内で2核が融合すれば、どちらの場合も $AaBb$ となり、これが減数分裂して生ずる担子胞子の四つの交配型は等しく AB, ab, Ab, aB であるからである。もっとも、Papazian (1950) の案出した新分析方法、すなわち出現複相菌糸をとって、四つの交配型の標準菌糸の単相大菌叢に接種し、その後の菌叢の発育状況から接種した複相菌糸の2核を推定するという方法によれば、ただ一つの系統を用いても実験の目的を達することができる。しかし著者の材料では Papazian の方法は分析の結果の正確を期することができなかったから、手数はかかるが不和合性因子を異にする二つの系統を組合わす Quintanilha (1938) の考案した方法に準じて、不和合性組合わせの diploidisation で現われた複相菌糸の2核を推定した。

すなわち、不和合性因子が全く異なる二つの系統、 $AaBb$ と $A'/a'B'/b'$ を用い、前者の AB と後者の $A'B'$ とを交配して子実体を作らせ、その単胞子培養から交配型 AB' の菌糸を得る。これと原菌糸とを用いての不和合性組合わせ $AB' \times (AB + A'B')$ で、 AB' 菌叢の周縁部に現われた複相菌糸の2核は、2核移行説によれば $AB + A'B'$ であり、染色体交換説によれば $AB' + A'B$ である筈である。この問題の複相菌糸をとって $AaBb$ 系統の Ab の大菌叢の周縁部に接種して diploidisation の実験を再び行う。今度の場合は $Ab \times (AB + A'B')$ 、又は $Ab \times (AB' + A'B)$ であるから和合性の組合わせである。上記のような不和合

性及び和合性の連続2回の組合わせを、以下 $Ab \times [AB' \times (AB + A'B')]$ のように略記することにする。そして Ab の周縁部に現われた複相菌糸の一部をとって培養し、生じた子実体よりの単胞子培養菌糸の交配型分析を行い、その結果 $Ab, A'B', AB', A'b$ の4交配型が見られたら、和合性組合わせは $Ab \times (AB + A'B')$ であったわけで、従って初めの不和合性組合わせで2核が移行したことの証明になり、もし $Ab, A'B, AB, A'b$ の4交配型であったら、和合性組合わせは $Ab \times (AB' + A'B)$ であり、前の不和合性組合わせにおいて新核 $A'B$ が出現したことになる。以上のような方法で不和合性組合わせによる diploidisation で現われた複相菌糸の2核を推定した。

Diploidisation の実験はペトリ皿内で、また子実体形成のための培養、及び交配型分析のための混植培養は試験管内で行い、培養温度は 30°C 、培養基はすべて馬鈴薯煎汁寒天を用いた。なお、単相大菌叢に複相菌糸を接種する方法や出現複相菌糸のとり方、交配型分析方法等は既報 (木村 (1954 a, b)) に準ずる。

本実験には X, Y (共に新潟市で松田一郎氏採集)、 c, d (共に倉敷市で著者採集) の4系統を用いたが、これらは互いに不和合性因子を全く異にし、異系統間の単胞子培養菌糸の組合わせ培養からは、すべて複相菌糸が生じた。これら4系統のそれぞれの不和合性因子に記号をつけるのは、いたずらに複雑であるから、二つの系統を組合わして実験を行う場合、一方を $AaBb$ (AB, ab, Ab, aB)、他方を $A'/a'B'/b'$ ($A'B', a'b', A'b, a'B'$) のように記することにした。

結果と考察

X と Y, c と X, d と X の2系統ずつを用いての既述の不和合性組合わせとこれに続く和合性組合わせの diploidisation の実験 No. 1~21、及びその結果は第1表のようである。

初めの不和合性組合わせでは No. 20 及び No. 21 を除いては全部 diploidisation が起り、単相大菌叢の周縁に複相菌糸が現われた。そして程度の差はあるが patchiness が例外なく見られた。これらの出現複相菌糸の2核を分析するため、引続いて行われた和合性組合わせでは No. 13 の外は Ab 又は aB の周縁に複相菌糸が生じ、また

No. 11 を除いては、いずれもこれより子実体を形成し、単孢子培養菌糸の交配型分析を行うことができた。結局、21 の組合わせの中、結果を得ることができたのは 17 であるが、この中、No. 10 を除く外は全部、Rawitscher が推論したように、不和合性組合わせによる diploidisation では接種した複相菌糸の 2 核が共に単相大菌叢中を移行して、その周縁部に、これら移行した 2 核で再び複相菌糸を形成することを示した。

本実験結果の中、特に興味あるのは No. 7 及び No. 9 において、不和合性組合わせでは勿論、引続いて行われた和合性組合わせでも再度の 2 核移行を示したことである。和合性組合わせによる diploidisation で 2 核移行が見られた実験例は、これまでにないことはないが、その数は極めて少ない (Dickson (1936), Quintanilha (1939))。そして、これらは著者の結果と同様に、単に偶然に得られたものであるが、和合性組合わせによる

第 1 表 不和合性組合わせと和合性組合わせの連続した diploidisation の実験とその結果

実験番号	組 合 わ せ	Ab 又は aB の周縁に現われた複相菌糸の 2 核
X 系統 (AaBb) と Y 系統 (A'a'/B'b') とを用いた場合		
1	Ab × [A'/B × (AB + A'/B')]	Ab + A'/B' *
2	aB × [A'/B × (AB + A'/B')]	aB + A'/B' *
3	"	aB + A'/B' *
4	aB × [A'/B × (AB + A'/B')]	aB + A'/B' *
5	aB × [AB' × (AB + A'/B')]	aB + A'/B' *
c 系統 (AaBb) と X 系統 (A'a'/B'b') とを用いた場合		
6	Ab × [A'/B × (AB + A'/B')]	Ab + A'/B' *
7	aB × [A'/B × (AB + A'/B')]	AB + A'/B' **
8	Ab × [A'/B × (AB + A'/B')]	Ab + A'/B' *
9	aB × [A'/B × (AB + A'/B')]	AB + A'/B' **
10	Ab × [AB × (AB' + A'/B)]	Ab + A'/B' ***
11	aB × [AB × (AB' + A'/B)]	aB に現われた複相菌糸が子実体を作らなかった
12	Ab × [AB × (AB' + A'/B)]	Ab + A'/B *
13	aB × [AB × (AB' + A'/B)]	aB に複相菌糸が現われなかった
d 系統 (AaBb) と X 系統 (A'a'/B'b') とを用いた場合		
14	Ab × [A'/B × (AB + A'/B')]	Ab + A'/B' *
15	aB × [A'/B × (AB + A'/B')]	aB + A'/B' *
16	Ab × [A'/B × (AB + A'/B')]	Ab + A'/B' *
17	aB × [A'/B × (AB + A'/B')]	aB + A'/B' *
18	Ab × [AB × (AB' + A'/B)]	Ab + A'/B *
19	aB × [AB × (AB' + A'/B)]	aB + AB' *
20	AB × (AB' + A'/B)	AB に複相菌糸が現われなかった
21	"	"

* 不和合性組合わせにおいて 2 核移行
** 不和合性組合わせだけでなく和合性組合わせにおいても 2 核移行
*** 新核形成
下記の菌糸は交配型は同じであるが互いに異なる胞子から由来したものである。
No. 1~3 の A/B と No. 4 の A/B
No. 6~7, 10~13 の A/B と No. 8~9 の A/B
No. 6~11 の AB と No. 12~13 の AB
No. 14~15, 18~21 の A/B と No. 16~17 の A/B
No. 14~19 の AB と No. 20~21 の AB

diploidisation における核の行動については別報で述べることにする。

No. 10 の結果は $AB \times (AB' + A/B)$ の不和合性組合せにおいて新核が生じ、これと AB とで複相菌糸を作ったことを示した。この新核は AB' 核の A 因子又は A/B 核の B 因子が突然変異を起した結果 $A''B'$ 又は A/B'' となったものではなくて、 AB' 、 A/B の 2 核の間で不和合性因子を交換したと思われる A/B' であることが交配型分析から確認された。Papazian (1950) も前述のような *Schizophyllum commune* を用いての diploidisation の実験で、13 通りの不和合性組合せの中、2 核移行が 6、上記のような不和合性因子の交換による新核形成が 2、不明 5 の結果を得ている。このような新核形成は Quintanilha が述べるように、不和合性組合せなるが故に、単相大菌叢の核と和合する必要にせまられて起ったものとは考えられない。何となれば Papazian は、例えば $aB \times (A/B' + a/b')$ のような両和合性組合せの場合でも A/B' 、 a/b' 2 核の間で不和合性因子交換による新核 a/B' が生じ、これと aB とで複相菌糸を作ったというような結果をしばしば得ており、著者 (未発表) は和合性組合せで、稀れではあるが同じような新核形成の例を見ている。故に新核形成は組合せの不和合性とか和合性とかには無関係に起るものであるといわなければならないであろう。このように論じてくると No. 10 で見られた新核形成は、必ずしも不和合性組合せにおいて起ったとは断定できず、引続いて行われた和合性組合せで起ったものかも知れない。

この新核形成という僅かな例外を除いては、不和合性組合せにおいては接種した複相菌糸の 2 核が単相大菌叢の中を移行した結果、大菌叢の周縁に新しく複相菌糸が生ずるものといえる。単相大菌叢中を 2 核が移行するのに、別々の菌糸の中を進むのか、或は同一の菌糸の中を 2 核が行く

のかという問題であるが、著者は後者であると考察している。また同一菌糸の中を 2 核が進む際に、conjugate division をせず各々自由に核分裂をしながら移行するものであり、従って 2 核の進行速度に遅速があるものと見たいが、これらについては別報で和合性又は両和合性の組合せの実験結果から論ずることにする。そして 2 核の進行速度に差があるため、一方が早く進んで周縁部に達しても他方が来なければ複相菌糸を作ることができないから、不和合性組合せでは、他の和合性、両和合性等の組合せに較べて diploidisation が遅れるのであろうという及川氏の説には賛同できる。

大菌叢の核をさし置いて、移行した 2 核で複相菌糸を作っていくことは上記の進行速度に遅速のあること、その他の点で多少の無理を伴うものと考えられ、そのため単相大菌叢の周縁のすべての菌糸の先端から複相菌糸が生じていくというわけにいかず、周縁部のある部分では複相菌糸が出現するが、他の部分では失敗するという結果、patchiness が見られるのであろう。また、和合性や両和合性の組合せに較べて、不和合性の組合せでは周縁部に複相菌糸が全然見われぬ場合が多いことも移行した 2 核で新しく複相菌糸を作ることの困難を示すものではあるまいか。patchiness は普通、不和合性組合せにおいてだけ見られるが、和合性組合せでも 2 核移行を示した前述の No. 7 及び No. 9 の場合、共に aB 大菌叢の周縁部に典型的な patchiness が現われた。

この patchiness の点から考えても Quintanilha の不和合性組合せでは、特に大菌叢の核と和合できる新核が生じ、これと大菌叢の核とで複相菌糸を作っていくという説には同意しかねるが、Papazian 及び著者の実験結果から新核の出現ということは、稀れではあるが、あり得るといわざるを得ない。

Summary

1. The present paper deals with the nuclear migration from the diploid mycelium into the haploid mycelium in the illegitimate combination, using *Coprinus macrorrhizus* Rea f. *microsporus* Hongo (a tetrapolar fungus).

2. Nuclear constitution of the resulting diploid mycelium was analyzed after Quintanilha's method (1938) in which three incompatibility factors of the A or the

B series were provided and the illegitimate combination was followed by the legitimate combination.

3. The results of analyses show migration of both nuclei of the diploid mycelium through the haploid mycelium, with one exception that exchange of incompatibility factors between the nuclei of a diploid mycelium seems to have occurred.

4. In the present experiments, two instances were obtained that both nuclei of the diploid mycelium passed through the haploid mycelium not only in the illegitimate but also in the legitimate combinations.

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本 会 記 事

支 部 通 信

北海道支部

第7回宮部博士記念講演会(4月27日, 於北大・農) 西山保直: 植物生長抑制物質について。柄内吉彦: 宮部先生を懷う。

札幌支部例会(9月28日, 於北大・農) 小塚芳道: 北見地方のエンレイソウの自然集団について。田中明: インド稻の栄養生理的特性。

中部支部

第5回講演会(5月21日, 岐阜大・農) 香川 彰: 甘藍の低温感応刺激の移行に関する研究。平吉功・松村正幸: ヌヒシバの発芽性の遺伝及び生理。加藤幸雄: シダ胞子の極性に関する二・三の実験。菅井道三・伊藤道夫: シダ *Protonema* の生長について。堀田康雄: シダ *Protonema* に存在する勾配と2次元分化。川松重信・原田市太郎: 二・三のヒツジグサ科植物の根の細胞間隙内の突出細胞群について。脇田時美: ガガバタ

(*Nymphoides indica* O. Kuntze) の形態について。高木典雄: 中部高山地域のキンシゴケ科(Ditrichaceae) 蘚類について。須賀瑛文: 愛知県産 *Heterodactylae* (異節類)—Charophyta (輪藻類)—について。熱尾 啓・神谷 平: 愛知県高等菌類について。神谷 平: 淡水産甲殻類に着生する藻類。熊沢正夫: 双子葉類における葉の開度と節間長との小週期的変化。谷口森俊: 志摩半島南部の植物群落。島村環: 細胞核の構造に関する最近の知見。近藤武夫・戸田英雄: コモチシダの不定芽と前葉体からの幼植物について。倉内一二: 生物季節とその利用 III—イチョウの個性性について。森 隆也: 花粉の活力判定への TTC 還元反応の利用について。大脇英男・森 隆也: 愛知県作手村長の山湿原の花粉分析。藤井良平: ミトリササゲの胚軸と根の生長に及ぼす赤色光の影響。岡本 尚: ミトリササゲ子葉から芽生へのカチオン輸送について。沢井輝男: *Candida tropicalis* var. *japonica* の amylase の糖による阻害について。岩崎秀一・

森 健志：脱莖素反応の研究—ヒドロキシラミンと亜硝酸の反応による酵素的ガス放出。

47 回例会（6月29日，於名大・理）森 孝子・日野精一・森 健志：嫌氣的莖素固定について，主として阻害実験。原田市太郎：クラミドモナスなどにおける性物質に関する近來の知見の紹介。

48 回例会（9月21日，於名大・理）市村国彦：アズキの生長と電位分布。樋口隆昌：ペルオキシダーゼ，ラッカーゼ，マツシユルム・フェノールオキシダーゼによるコニフェリルアルコールの重合物について。

近畿支部

5月例会（5月19日，於京大・理）馬場三吾：癒傷組織形成の際における組織の酸度，水素イオン濃度，酸化還元電位の変化について。高木虎夫：竹笹科八属十九種の開花現象。瀬戸良三・広瀬広幸：日本産カワモズクの単孢子及び果孢子の初期発生についての観察と考察（予報）。香山時彦：重金属イオンに対する霊菌の行動。清水健美：豊口山の植物相。坪 由宏：クラミドモナスの接合時にみられる走化性。

北陸支部

27 回例会（9月14日，於福井大・学芸）摺恵美・柴田万年：*Pennisetum japonicum* Trin.の花穂における色素について。木村久吉：トロピン含有ナス科植物の発芽物質について。

中国・四国支部

香川大会（5月18～20日，於香川大・学芸）谷本土佐雄：クモノスカビ（*Shizopus nigricans*）における桑実形孢子嚢について。西林長朗・猪野俊平：スジメの遊走子嚢発生と遊走子形成。越智春美：*Bryum nagasakense* Broth. の分類学的位置。山本昌木・岡田 淳：*Shiraia bambusicola* P. Hemm. について。栗田正秀：センニンソウ属（*Clematis*）数種の核型。神野大野：ナガバキイチゴの変異について。金子賢一郎：キク属種間交配における花粉管伸長について。武丸恒雄：エノキタケの一系統にみられる交配反応の乱れについて。内川 勇：普通コムギのX線突然変異について。木村劫二：和合性複相菌糸による帽菌類の diploidisation について。斎藤雄一：ク

リの花柱分化の人為交配について。田中隆荘：ナカガワノギクにおける種の分化。長野誠次：歐洲産苔類数種の細胞学的研究。下斗米直昌・重信陽二・山本正明・勝部 勝：*Chrysanthemum indicum* 群の細胞学的及び地理学的研究。日出武敏：*Euastrum* 属の日本新産種。原 幹雄：奄美大島の苔類フロラについて。鈴木兵二：日本産ユガミミズゴケ類の分類と分布。森 千春：日本におけるアコウの分布考。中村 純：奄美大島の湿原の花粉分析。沢良木庄一：アカマツ林の着生蘚苔群落。伊藤秀三：生物的攪乱に伴う草原群落構造の変動（予報）。笠原安夫：裏作麦と雑草の生育競争に関する研究。西山一穂：鳥取砂丘の海岸及び砂丘植物群落の土壤条件について。生駒義博・岩垣 寛：鳥取砂丘植物の地下器官。高木恭介：水稻の生育に対する微量元素 Mn, Mo の影響について。宮本義男・三戸昭：ミドリガキから分離された耐銅性微生物について。三戸 昭：酵母菌の重金属に対する Tolerance について。達川義信：ミドリガキから分離された耐銅性細菌の脱水素作用。古川満男：パラフィン培地による *Nocardia* の培養。福田八十楠：砂丘植物の蒸散（続）。玉置 秩・中潤三郎・藤田 勲：MHの葉面撒布が馬鈴薯体内成分の消長に及ぼす影響について。中潤三郎・玉置 秩：馬鈴薯二次生長の発生に伴う体内成分の変化について。

九州支部

43 回例会（2月9日，於九大・理）西村昭二：キョウチクトウの花色について。茅野 博：ノヒメユリ胚嚢母細胞における過剰染色体の選択的分離。

44 回例会（4月13日，於九大・理）前田 敏：*Acer insulare* Makino の葉面吸収の経路。小林 精：頻度に基づいた着生植群の区分け。

45 回例会（6月22日，於九大・教養）牧川鷹之祐：本草学の近代科学への移行。

46 回例会（9月28日，於福岡女子大）長田武正：北鮮蘚類フロラについて—付 日本における蘚類分類学の現況。清水正元：メヒシバ属植物の生理生態とその防除法。

Pflanzensoziologische Untersuchungen über Buchenwälder am Berg Kammuri, Provinz Hiroshima*

von Yoshiyuki SASAKI**

佐々木好之**: 冠山(広島県)におけるブナ林植生の研究*

Eingegangen am 20. Juli 1957

Es ist eine bekannte Tatsache, dass die *Fagus crenata* Blume in Japan von Norden (Süd-Hokkaido) nach Süden (Kyushu) weit verbreitet ist, und dass sie in den sommergrünen Laubwäldern unter ozeanischem Klima ein Klimax formiert. Aber die Gegend, in der sich die Vegetation der Buchenwälder vorherrschend entwickelt, ist die dem Japanischen Meer gegenüberliegende Region von Süd-Hokkaido, Tohoku und Hokuriku. In anderen Gegenden zeigt sie keine besonders weit verbreitete Entwicklung (T. Suzuki 1949, Y. Horikawa 1956). Soviel wir wissen, sind die Buchenwälder im Chugokugebiet des südwestlichen Japan im allgemeinen nur im Gipfelgebiet der Chugokugebirgskette verbreitet.

Deshalb sind die Berichte über die Vegetation der Buchenwälder in dieser Gegend mit Ausnahme von Y. Horikawa (1935) und Y. Satô (1937) verhältnismässig gering. In dieser Arbeit berichten wir über pflanzensoziologische Untersuchungen der Vegetation der Buchenwälder am Berg Kammuri, der sich im südwestlichen Teil der Chugokugebirgskette befindet, wo wir uns von 1953 bis 1956 mit der Erforschung beschäftigten.

Die grundlegenden Gesellschaftseinheiten, die in diesem Bericht verwendet werden, entsprechen der Deutung von J. Braun-Blanquet (1951).

Gebiete und Methoden der Untersuchungen

Der Kammuri, dessen Gipfel sich 1339 m über dem Meeresspiegel erhebt, ist einer von den höchsten Bergen in dem südwestlichen Teil der Chugokugegend. Nach der geologischen Untersuchung gehört der Kammuri zu der Ôta Gruppe der paläozoischen Chichibu-Schichten, die hauptsächlich aus Tonschiefer und Sandstein besteht. Floristische Untersuchungen des Gebietes sind nach K. Oka (1950) und M. Wada (1953) im Detail verrichtet worden, und neuerdings hat auch Y. Horikawa (1956) eine Pflanzenliste des Kammuri herausgegeben.

Unter etwa 1100 m ü.M. am Kammuri ist der grösste Teil der Naturwälder

* Beiträge aus dem phytotaxonomischen und geobotanischen Laboratorium, Hiroshima Universität. N. Ser. Nr. 39.

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künstlich zerstört worden; an ihrer Stelle haben sich die sogenannten sekundären sommergrünen Laubwälder entwickelt. Andererseits sind die verhältnismässig stabilisierenden Buchenwälder, worin unsere Untersuchungen praktisch ausgeführt wurden, in der Nähe von Gipfel und Bergrücken über 1100~1200 m ü. M. üppig gewachsen.

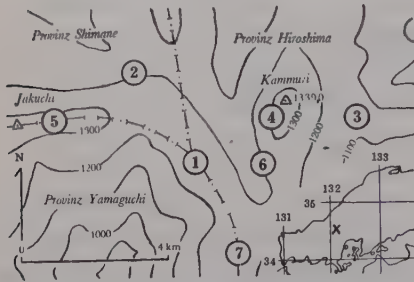


Abb. 1. Untersuchte Area und Aufnahme-nummer.

In diesen Buchenwäldern wählen wir sieben Aufnahme-flächen aus, die die homogenen Strukturen der Pflanzengesellschaften aufweisen (Abb. 1). Um Artenzusammensetzung der Buchengesellschaften noch genauer zu untersuchen, haben wir ferner in jeder Aufnahme-fläche je 5~10 Probequadraten von 10 m² Fläche aufs Geratewohl ausgelegt. Um den Dominanzwert der vorkommenden Arten in den verschiedenen Vegetationsschichten

jeder Probe-fläche auszudrücken, wurden die von Cain und Penfound (1938) eingeführten sechsteiligen Deckungsgrade gebraucht.

Versuchsergebnisse und Diskussion

1. Benennung der Pflanzengesellschaften. Schon H. Nakano (1942 a. b.) bezeichnete die japanischen Buchenwälder als einen Verband *Fagion crenatae*. Diese Benennung scheint uns heute noch gültig zu sein. Aber wir sind mit Nakanos Klassifizierung der Untereinheiten wie Assoziationen und Subassoziationen deswegen unzufrieden, weil es ihren Einheiten am Begriff der Gesellschaftstreue mangelt. Dagegen bestimmte T. Suzuki (1952) in *Fagion crenatae* auf Gesellschaftstreue gründend zwei Assoziationen; nämlich *Saseto-Fagetum crenatae* der Japanischen Meerseite und *Sasamorpheto-Fagetum crenatae* der Pazifischen Ozeanseite.

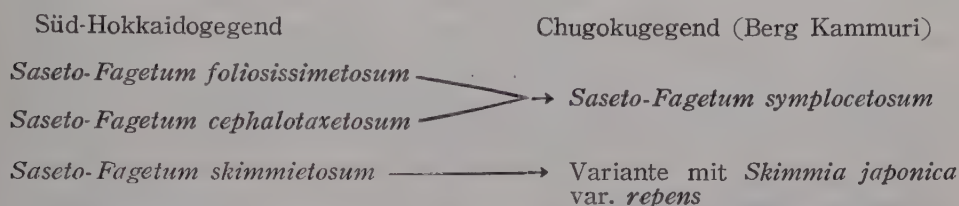
Betrachten wir hier die Artenzusammensetzungsverhältnisse der zwei Assoziationen und unsere Assoziationstabelle 1. Erstens fehlt es den Buchenwäldern des Kammuri vollständig an immergrünen Nano-Sträuchern *Aucuba japonica*, *Daphniphyllum humile* und *Ilex, leucoclada*, die mit *Saseto-Fagetum crenatae* charakteristisch verbunden sind. Zweitens haben die Buchenwälder des Kammuri die wichtigen Charakterarten für *Sasamorpheto-Fagetum crenatae*, wie *Stewartia pseudo-camellia*, *Acer sieboldianum*, *Symplocos coreana* usf. in grösserer Menge.

Dominanzarten der Strauchschicht der beiden Assoziationen sind auch die immergrünen Sträucher, Gattungen *Sasa* und *Sasamorpho*, dagegen sind die Dominanzarten unserer Buchenwälder die sommergrünen Sträucher, *Symplocos coreana* und *Lindera umbellata*.

Auf Grund solcher Tatsachen lässt es sich im Augenblick nicht entscheiden, ob die Buchenwälder des Kammuri zu *Saseto-Fagetum crenatae* gehören oder zu *Sasamorpheto-Fagetum crenatae*. Dennoch wies neuerdings T. Suzuki (1956) darauf hin,

dass *Saseto-Fagetum crenatae* Nadelbäume wie *Cryptomeria japonica* und *Thujaopsis dolabrata* als wichtige Begleiter habe. Unter Berücksichtigung dieser Tatsachen halten wir es für angemessen, den Buchenwald des Kammuri eine Subassoziation (*Saseto-Fagetum crenatae symplocetosum*) zu nennen.

T. Suzuki (1949) hat bereits in Süd-Hokkaido vier Subassoziationen von *Saseto-Fagetum crenatae* unterschieden. *Foliosissimetosum* und *Cephalotaxetosum* in seinen Subassoziationen entsprechen mehr oder weniger physiognomisch unserem *Symplocetosum*. Andererseits verliert auch seine *Skimmietosum* ihre Selbständigkeit in unserer Gegend, und wir können sie deshalb als „Variante mit *Skimmia*“ am Berg Kammuri ansehen; wir finden nämlich dort geographische Gradienten der Subassoziationen wie folgendes Schema zeigt:



2. Schichtenbildung der Buchenwälder. Abb. 2 zeigt schematisch die Schichtenbildung der untersuchten Buchenwälder: Die obere Baumschicht wird meistens durch *Fagus crenata* gedeckt, an einigen Stellen wird sie aber durch *Cryptomeria japonica* oder *Acer sieboldianum* ersetzt. *Symplocos coreana* dominiert fast in der unteren Baumschicht, aber es ist nicht immer gesagt, dass die Grenze zwischen ihrer Schicht und der durch *Lindera umbellata* gedeckten Strauchschicht überall deutlich ist.

Es ist ein bemerkenswertes Phänomen, dass diese sommergrünen Sträucher *Symplocos coreana* und *Lindera umbellata* anstatt *Sasa*, das in Buchenwäldern der anderen Gegend üppig wächst, als Dominanzarten der Untervegetation unserer Buchenwälder üppig gedeihen.

Im allgemeinen ist die Untervegetation der Buchenwälder an der Chugokugegend oft besonders mit *Lindera umbellata* bedeckt, z. B. soviel wir wissen die Buchenwälder des Bergs Daisen, Hibayama, Ôyorigi, Kario (Garyu) usw. Auch das Phänomen, dass die Krautschicht vollkommen durch *Carex foliosissima* bedeckt wird, tritt nicht allein am Kammuri auf, sondern auch am Berg Kario, Sarumasa, und nahe am Gipfel des Osorerakan im Chugokugebirge.

In Buchenwäldern anderer Gegenden am nördlichen Teil der Kantogegend von Zentral-Japan mit Ausnahme von Süd-Hokkaido, bildete H. Usui (1955) *Saseto-Fagetum crenatae caricetosum*, deren Strauchschicht kein *Sasa* aufweist und durch *Carex morrowii* bedeckt wird. Viele interessante Probleme ergeben sich daraus, dass sich dieses *Caricetosum* in dem Zwischengebiet von verbreiteten Arealen der vorhergehenden zwei Assoziationen entwickelt, und die geographischen Verhalten denen des Kammuri entsprechen.

Moosschicht findet sich fast ohne Ausnahme nicht vor. Aber die Entwicklung kryptogamen Baum-Epiphytengesellschaften, besonders von einschichtigen Moosgesellschaften ist überaus vortrefflich. Über diese Epiphytengesellschaften hat schon Y. Horikawa & S. Nakanishi (1956) im Detail berichtet. Nach seinen Untersuchungen finden sich Dominanzarten der Moosgesellschaften in der Nähe von Gipfel und Bergrücken, *Macrosporiella dozyoides*, *Boulaya mittenii*, *Frullania moniliata* subsp. *obscura*, *Okamuraea cristata*, *Ulotia crispa* usw.

Auf Grund oben erwähnter Tatsachen, kann man die stabile räumliche Struktur der Buchenwälder am Kammuri durch ein *Fagus-Lindera-Carex*-Typ der Schichtenbildung charakterisieren. Auch *Lindera*- und *Carex*-Schichten fallen in die Kategorie der sogenannten „eng verbundenen Schichten“ (Br.-Bl. 1. c.).

Abb. 2. Schematische Schichtenbildung der *Saseto-Fagetum crenatae* *symplocetosum*.

Schwarz = Dominanzarten der verschiedenen Schichten in jeweiliger Aufnahmefläche
Schraffiert = Subdominanzarten der verschiedenen Schichten in jeweiliger Aufnahmefläche

Aufnahmenummer	1	2	3	4	5	6	7
15~25 m. Obere Baumschicht:							
<i>Fagus crenata</i>							
<i>Cryptomeria japonica</i>							
<i>Acer sieboldianum</i>							
2 ~ 3 m. Untere Baumschicht:							
<i>Symplocos coreana</i>							
<i>Acer carpinifolium</i>							
<i>Viburnum furcatum</i>							
0.5~2 m. Strauchschicht:							
<i>Lindera umbellata</i>							
<i>Hidrangea hirta</i>							
<i>Cryptomeria japonica</i>							
<i>Cephalotaxus nana</i>							
<i>Hydrangea macrophylla</i> v. <i>acuminata</i>							
<i>Skimmia japonica</i> v. <i>repens</i>							
<i>Sasa veitchii</i>							
Unter 0.5 m. Krautschicht:							
<i>Carex foliosissima</i>							
<i>Plagiogyria matsumureana</i>							
<i>Comanthosphace stellipila</i> v. <i>sublanceolata</i>							
<i>Cacalia yatabei</i> v. <i>occidentalis</i>							

3. Standortsfaktoren. Nach dem klimatographischen Atlas der Provinz Hiroshima (1953) ist die jährlichen Mitteltemperatur in der Umgegend des Kammuri 9.7°C, und die jährliche Niederschlagsmenge 2480 mm. Die Niederschlagsmenge wird auch durch Schneefall im Januar und Dezember, durch „Baiu“ (Regenzeit) im Juni, und durch Taifunregen im September vermehrt (Abb. 3). Diese Tatsache offenbart sich, dass die untersuchte Gegend im Zwischengebiet von zwei bedeutenden Klimaprovinzen liegt, nämlich der Klimaprovinz der Japanischen Meerseite und der Pazifischen Ozeanseite in Japan (Fukui 1933).

Der Boden der betreffenden Wälder weist die typische Braunerde auf, ihr Boden-

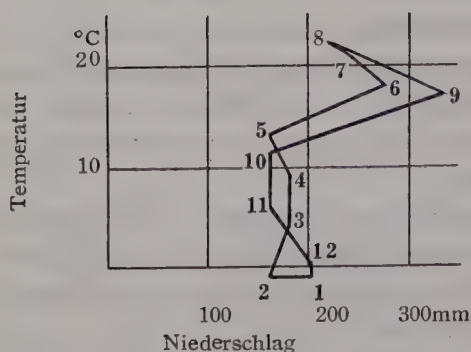


Abb. 3. Klimographie von Geihokugegend, Provinz Hiroshima.

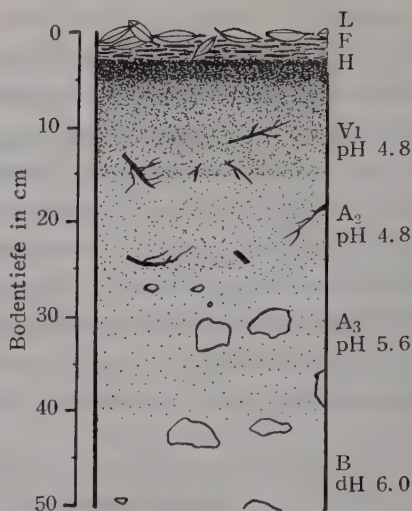


Abb. 4. Bodenprofil am Aufnahmenummer 2

profil ist in Abb.4 dargestellt. Der Boden wird genauer in A- und B-Schicht eingeteilt, die erstere zeigt ein schwärzliches Braun, die letztere ein gebliches Braun. Die A-Schicht lässt sich noch einmal in drei Subschichten einteilen. Der pH-Wert von B-Schicht zeigt schwächere Säurigkeit als A-Schicht. Der Boden ist im allgemeinen feucht.

Konklusion und Zusammenfassung

1. Bei den pflanzensoziologischen Untersuchungen über Buchenwälder am Berg Kammuri haben wir die folgenden Pflanzengesellschaften unterschieden:

Saseto-Fagetum crenatae symplocetosum

Fazies mit *Sasa veitchii*

Variante mit *Skimmia japonica* var. *repens*

Variante mit *Comanthosphace stellipila* var. *sublanceolata*

Variante mit *Cacalia yatabei* var. *occidentalis*

2. Diese Gesellschaften bilden eine Übergangsform zwischen dem an der Japanischen Meerseite wachsenden *Saseto-Fagetum crenatae* und an der Pazifischen Ozeanseite vorkommenden *Sasamorpheto-Fagetum crenatae*. Diese Tatsache wird auch durch die oben erwähnten Klimafaktoren bestätigt (Abb. 3).

3. Vegetationsschichtung der Buchenwälder besteht aus einem *Fagus-Lindera-Carex*-Typ der Schichtenbildung.

4. Da der Standort der untersuchten Area im allgemeinen ziemlich feucht ist, so bestehen Untervegetationen hauptsächlich aus den Pflanzen, die gewöhnlich in Tälern oder in Schluchten wachsen, wie *Symplocos coreana*, *Carex foliosissima*, *Cacalia yatabei* var. *occidentalis*, *C. tebaensis*, *Comanthosphace stellipila* var. *sublanceolata* usw. Daher lassen sich die Buchenwälder des Kammuri, wie Tüxen gezeigt hat (Br.-Bl.1.c), in die feuchte Subassoziationsgruppe einordnen.

Hier sei es dem Verfasser gestattet, seinem verehrten Lehrer, Herrn Prof. Dr. Yoshiwo Horikawa, Hiroshima Universität, für seine Anregung und stetige Anleitung aufrichtigen Dank auszusprechen. Ebenfalls ist er auch Herrn a.o. Prof. Hyôzi Suzuki, Hiroshima Universität, für seine stets unveränderte Hilfsbereitschaft zu grossem Dank verpflichtet. Besonderen Dank schuldet der Verfasser Herrn Prof. Dr. Tokio Suzuki, Universität Ôita, für seine gütige Unterstützung und wertvollen Ratschläge.

Literatur

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Taxonomic Study of Cyperaceae 7**

Tetsuo KOYAMA*

小山鐵夫*: カヤツリグサ科の分類学的研究 7**

Received August 1, 1957

§ 18. The systematic position of *Carex* Sect. *Decorae* with a taxonomic treatment of the Japanese species.

The section *Decorae* is a natural group of sedges, of which the members are most abundant in the Indo-Malaysian floristic region. *Carex Reinii* Fr. et Sav. is only hardy Japanese species of the section, but this is rather an aberrant species in the morphological respect. The typical sedges of *Decorae* shows a vegetative appearance similar to that of *Indocarex* by their spaced cauline leaves, and in having large, paniculate or fasciculate inflorescences with mostly androgynous spikelets. Thus *Carex tokarensis* T. Koyama and Formosan *Carex Morii* Hayata are typical.

Decorae was first created by Dr. Kükenthal in 1909 as a subsection under the section *Frigidae*. In this attempt, he also placed *Mucronatae*, *Fuliginosae*, *Ferruginae*,

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**Continued from Journ. Jap. Bot. 32: 153 (1953)

Podogynae and Curvicolles as subsections under that section together with Decorae. All these groups are characterized by more or less compressed and commonly pubescent perigynia with faintly nerved texture, and often brown-coloured scales surrounding them. Recently, most caricologists, however, regard that Curvicolles and Podogynae are to be rather near to the Atratae group, and the others except Decorae, viz. Mucronatae, Fuliginosae and Ferruginae, form a natural group broadly conceived as Frigidae. But, only for Decorae we have never found its suitable relationship to any group of the Eucarex proper.

The fascicled spikelets commonly seen in Decorae in various degrees are a rare occurrence in the Eucarices of the normal kind. We generally consider these fascicled spikelets to be more primitive than the normal spicate or racemose ones, because we approve of thinking that in Cyperaceae, a reduction of spikelets leads a certain trend of evolution. As to the origin of these fascicles, Mr. Nelves supposed an ordinary panicle and a combination of fasciculate and paniculate inflorescences as the two different ancestral types of spikelets from which the fascicles would have been descended. Here I prefer his former view for the reason that the paniculate inflorescences of a common form are availing in the present-day Indocarex, whereas the latter we have never really seen even in the extra group of Caricoideae, and that some species of Indocarex are without doubt risen closest to certain species of Decorae systematically. In the course of the estimated reduction of inflorescence, perfectly fascicled spikelets are thought to be derived from normally paniculate inflorescence through a transitional form or partially fasciculate panicle, as shown in the schema given below.

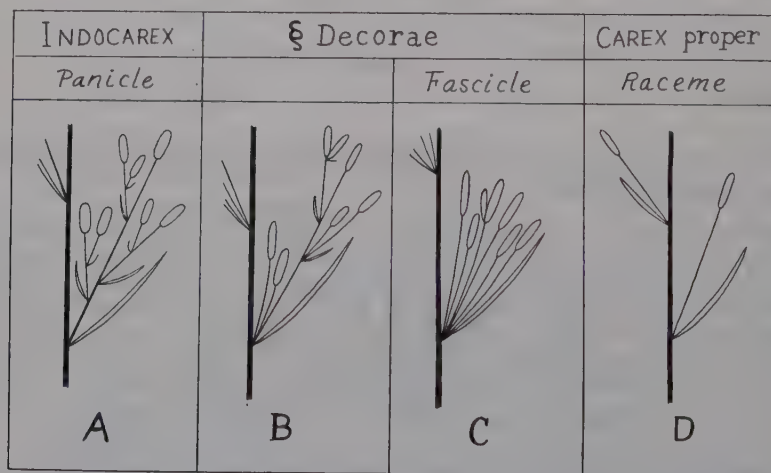


Fig. 9. Schema showing a supposed reduction series of paniculate partial inflorescence, from A to D.

In the Japanese species, *Carex tokarensis* shows a criterion of perfectly fascicled spikelets considered to be of the latest state within this section (Fig. 9: C). *Carex Morii* is a representative of the transitional state (Fig. 9: B). *Carex Reimii* is, I think, a

more reduced form of Fig. 9-C, and it often bears such racemose spikelets as seen in *Eucarex* of a normal kind. For the more primitive paniculate state of Fig. 9-B, I give *Carex perakensis* (= *C. Dunni*) as an example. The traditional treatment makes this species belong to Indicae of Indocarex, for it is apparently of the Indocaricoid form and with less compressed perigynia. But, the nature of perigynia, scales and vegetative parts seems to be more closely related to the members of Decorae than to those of Indicae, and I transfer it from Indicae to Decorae. *Carex perakensis* Clarke shows a link between Indicae and Decorae, or a link between Indocarex and Eucarex. It is also of interest that a tendency of the compressedness of achenes in their transverse sections, from trigonous to dorsally compressed, agrees with the series of reduction of inflorescences in the above schema. If the achenes of Decorae completely lose their dorsal angle, they will become a lenticular achene seen in Graciles (*Carex brunnea* group). On the one hand, the parallelism of the reduction of inflorescences and the similarity of the texture of perigynia to the members of Decorae are noted in the member of Graciles, however, it is not certain whether Graciles directly descended from an Indocaricoid ancestor or derived through an intermediate form just like Decorae species.

In 1936 Dr. Ohwi raised the subsection Decorae to a sectional status (Cyper. Japon. 1: 338). Then he included two species, *C. Reinii* and *C. Morii*, in it, and placed it between the sections Ferrugineae and Praecoces, thinking Japanese *C. Reinii* to be near to Mitratae group. In Dr. Akiyama's latest opus on *Carex* (Carices Far East. Reg. As. 133, 1955), Decorae is also placed next to the section Ferrugineae. Both treatments must lay stress on the compressed perigynia with pubescent, faintly nerved, rather thin texture found in either Ferrugineae or Decorae. Concerning the position of Decorae, however, I do not agree with these views, but with Mr. Nelves' later opinion stated in his monograph of the *Carex* in Malaysia (Reinwardtia 1: 1951), in which Decorae and Graciles follow Indocarex. This view is supported not only by the above mentioned morphological basis but also by the distribution of the section Decorae having its center in Indo-Malaysia where Indocarex is most differentiated.

Sectio **Decorae** (Kükenthal) Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. Ser. B, 11: 338 (1936) — Nelves in Reinwardtia 1: 332 (1851), et in Mém. Mus. National Hist. Nat. N. S., Ser. B, 4: 138 (1955) — Akiyama. Carices Far East. Reg. As.: 133 (1955).

Sectio *Frigidae* subsection *Decorae* Kükenthal, Cyper. Caric. 541 (1909).

Species typica: *Carex decora* Boott.

A key to the Eastern Asiatic species:

- A) The terminal spikelet merely staminate, spikelets 3-12, single or 3 from one bract. 1. *C. Reinii*.

- A) All spikelets androgynous, spikelets numerous, arranging in fascicles of 3 to 12 or in panicle.
- B) Apices of achenes discoid-annulate, spikelets fascicled in group of 4-9, on long-exserted capillary peduncle of equal length. 2. *C. tokarensis*.
- B) Apices of achenes gradually tapering to style, spikelets paniculate or partially fascicled with very unequal peduncles.
- C) Spikelets linear-cylindrical, 3-9 cm long, perigynia glabrous, nearly as long as female scales. 3. *C. Sakonis*.
- C) Spikelets oblong, 1-2 cm long, perigynia wholly pubescent, conspicuously longer than female scales.
- D) Female scales deltoid-ovate, fuscous, half as long as perigynium, perigynia much compressed, achenes 3.5-4 mm long, compressed-trigonous. 4. *C. Morii*.
- D) Female scales ovate-oblong, ovate-lanceolate or oblong-obovate, whitish to light fulvous, almost 2/3 as long as perigynium, perigynia clearly trigonous, achenes 3 mm long, obovate, triquetrous. 5. *C. perakensis*.

1. *Carex Reinii* Franchet et Savatier, Fnum. Pl. Japon. 2: 133 (1877) et 559 (1879); Franchet, Car. As. Or. t. 7, f. 1 (1896) et 115 (1897); Matsumura, Index Pl. Japon. 2-1: 130 (1905); Akiyama in Journ. Fac. Sci. Hokkaido Imp. Univ. Ser. 5, 2: 150, f. 97 (1932), et Car. Far East. Reg. A s. 134, tb. 120: f. 1 (1955); Ohwi in Mem. Coll. Sci. Kyoto Imp. Univ. Ser. B, 11: 338 (1936), et Fl. Jap. 192 (1953) — Japan, Savatier 3489.

C. nambuensis Franchet in Bull. Soc. Philom. Paris 8^e sér., 7: 44 (1895), et *Carex* As. Or. t. 9, f. 2 (1896) et 115 (1897); Lév. et Van't. in Bull. Acad. Intern. Géogr. Bot. 10: 196 (1901); Matsumura, l. c. 121 — Japan, Faurie. 2172.

C. Ogawai Akiyama in Journ. Fac. Sci. Hokk. Imp. Univ. Ser. 5; 2: 172. f. 118 et t. 10 (1932), et Car. Far East. Reg. As. 134, tb. 119 (1955) — Japan, Ogawa. Japan (Honshu, Shikoku, Kyushu).

C. Reinii was described from a young small plant collected at Hakone. This species varies in shape and size of female scales and perigynia to some extent, and the number of spikelets are utterly ascribable to the degree of growth. A well grown plants have many fascicled spikelets in group of 2 to 3 to one bract, on tall culm reaching to 9 dm in height. *C. Ogawai* is attributed to this large form of the species.

2. *Carex tokarensis* T. Koyama in Acta Phytotax. et Geobot. 16: 7, tb. 3; ff. A-I (1955) — Liukiu, Naito.

Liukiu (Tokara Isls.).

Known only by the type collection. This species is striking by its achenes discoid-annulate at the apical end. Other species have beaked achene or spongily thickened style base.

3. *Carex Sakonis* T. Koyama, spec. nova

Perdense caespitans. *Folia* pluria linearia 3.5-7 mm lata 7-9 dm longa culmum multo superantia rigida plana vel sursum subconduplicata unicostata marginibus supra medium scabra ad apicem longissime gradatim attenuantia basi in *vaginas* antice membranaceas dorso fusco-brunneas purpureo-brunneasve vix angustata; *vaginae basillares* demum in fibras parallelas sordide brunneas solutae persistentes. *Culmi* erecti 7 dm alti ad angulos obtusiusculos scabri basi pauci-(ad 2) foliati a medio ad apicem spiculigeri. Inflorescentia paniculata 3-4 dm longa deorsum interrupta sursum subcontigua; *spiculae* ex unica bractea singulae usque 2-5 fasciculatim enatae valde inaequialtae saepe ad partem basilarem autem 2-3-ramosae, omnino androgynae (sed rarissime summa tantum mere mascula) linearicylindricae (1.8-) 4-8 (-9) cm longae cum *pedunculis* capillaribus scabris vulgo longe exsertis cernuae vel pendulae, *parte foeminea* ea mascula brevior usque cum ea aequilonga subdensiflora et in parte basilari saepe distantiflora 1.5-5 cm longa ad 5 mm crassa, *parte mascula* lineari spisse pluriflora ferrugineo-fusca; *bractae* foliaceae inflorescentia longiores basi vaginas 2-5 cm longas formantes. *Squamae* floris foemineae oblongo-ellipticae naviculares 4-5 mm longae (aristam excluendae) fere 2 mm latae membranaceae fusco-fluviae, costa subangusta inconspicue trinervata ex apice squamae in aristam scabromarginatam recurvam 1.5-5 mm longam subabrupte excurrente. *Utriculi* erecto-patentes squamam paullo superantes oblanceolato-oblongi vel fusi-formis 5.5-6.3 mm longi 1 mm lati trigoni membranacei glabri praeter nervos 2 laterales subnervi olivaceo-virentes basi cuneato-contracti breviter (circiter 4/5 mm) stipitai apice gradatim attenuantes in *rostrum* rectum longum margine hispiduloso-scabrum 2 mm longum, *ore* bifurcato, dentibus acutis 4/5 mm longis. *Nuces* (immaturae) ellipticae trigonae parvulae, stylo longo deorsum saepe flexuoso basi subaequali, stigmatibus 3 cum 2/3 longitudine utriculi aequilongis.

Carex turrita C. B. Clarke prope quidem accedit, differt tamen squamis apice obtusis ad 3.5 mm longis, utriculis coriaceis nervosis, vaginis foliorum rubentibus etc.

Liukiu: Is. Amami-Ohsima, Yamma in Sumiyomura village, 1m alt. Coll. S. Sako, n 317!, 31 Jan., 1957 — holotype in TI. Is. Iheyajima. Coll. Shoei Tamashiro, 683!, 30 Dec., 1956.

At a glance this new species resembles *Carex turrita* C. B. Clarke of Luzon, from which this is easily separable in having filiform peduncles longly exserted from the sheath of bract and by the perigynium characters stated in the above description. The epithet is dedicated to Mr. S. Sako of the Kagoshima University, who first collected this strange *Carex*. Strictly endemic sedges to the Ryukyus are 3, *C. collifera* Ohwi, *C. tokarensis* T. Koyama and the present one. All these species have their nearest species in Indo-Malaysian region. Really, there are many sedges of Indo-Malaysian region marking their northernmost limit in Ryukyus. *C. breviscapa* C. B. Clarke and *C. brachyathera* Ohwi are good examples. Some Ryukyu sedges occur in Indo-China but not extending into Malaysia. *C. aliiformis* C. B. Clarke

and *C. teinogyna* Boot fall under this category. We seldom notice such species distributed in both Central China and Ryukyus.

4. *Carex Morii* Hayata, Ic. Plant. Formos. 6: 135, f. 46 (1916) et 10: 64 (1921); Ohwi in Japan. Journ. Bot. 7: 198 (1934), et in Mem. Coll. Sci. Kyoto Imp. Univ. Ser. B, 11: 339 (1936); Akiyama, Caric. Far East. Reg. As. 134, t. 120, f. 2 (1955) — Formosa, Mori.

Formosa (Southeastern part).

This is a good species known only from Formosa. In the external appearance, *C. Merrillii* Kükenthal of Luzon and this are somewhat alike. I made a figure of a partial inflorescence and a perigynium with its scale and achene from Dr. Hayata's type specimen (see T. Koyama, in Acta Phytotax. Geobot. 16: 8, t. 3, ff. J-M.).

5. *Carex perakensis* C. B. Clarke in Hook. f., Flor. Brit. India 6: 720 (1894); Nelmès in Mém. Mus. Nation. Nat. Hist. N. S., Ser. B, 4: 144 (1955); T. Koyama in Le Nat. Canad. 82: 195 (1955) — Malay Penins., Wray.

C. Wightiana Nees var. *perakensis* (C. B. Clarke) Kükenthal, Cyper. Caric. 288 (1909).

C. Dunii Hayata, Mater. Flor. Formos. 382 (1911); Akiyama, l. c. 137 (1955) — Formosa, T. Kawakami & U. Mori 1350.

C. Tatewakiana Ohwi in Acta Phytotax. Geobot. 1: 299 (1932) — Formosa, Tatewaki.

Formosa, Indo-China, Malaysia (Sumatra, Borneo, Celebes).

For the detailed synonymy see T. Koyama l. c., 1955. The complicated synonymy shows that this species is very difficult to define. The distributional pattern of *C. perakensis* is quite common with that of *Cyperus radians* Nees et Meyen, a peculiar species growing in sandy coast. These are distributed on both sides of the South China Sea. This pattern of distribution is called the Amphi-South China Sea elements.

§ 19. *Carex parciflora* group: its relation with *Carex Jackiana* and its variations in Japan.*

Carex parciflora Boott in a wide sense is a very variant species known from Japan, from Saghalien and the southern Kuriles to Kyushu and the southern Korea. *C. Jackiana* Boott (Fig. 10) is the nearest and the only allied species to *C. parciflora*. This was first reported from Java and at present as the Himalayan *C. instabilis* Boott is regarded to be conspecific with it, its area of distribution lies from Himalaya through high mountains of the eastern Malaysia to Australia (according to

* In preparing this section, I am grateful to Dr. N. L. Bor (Kew Gardens) through whom I was able to see Indian *Carex Jackiana*.

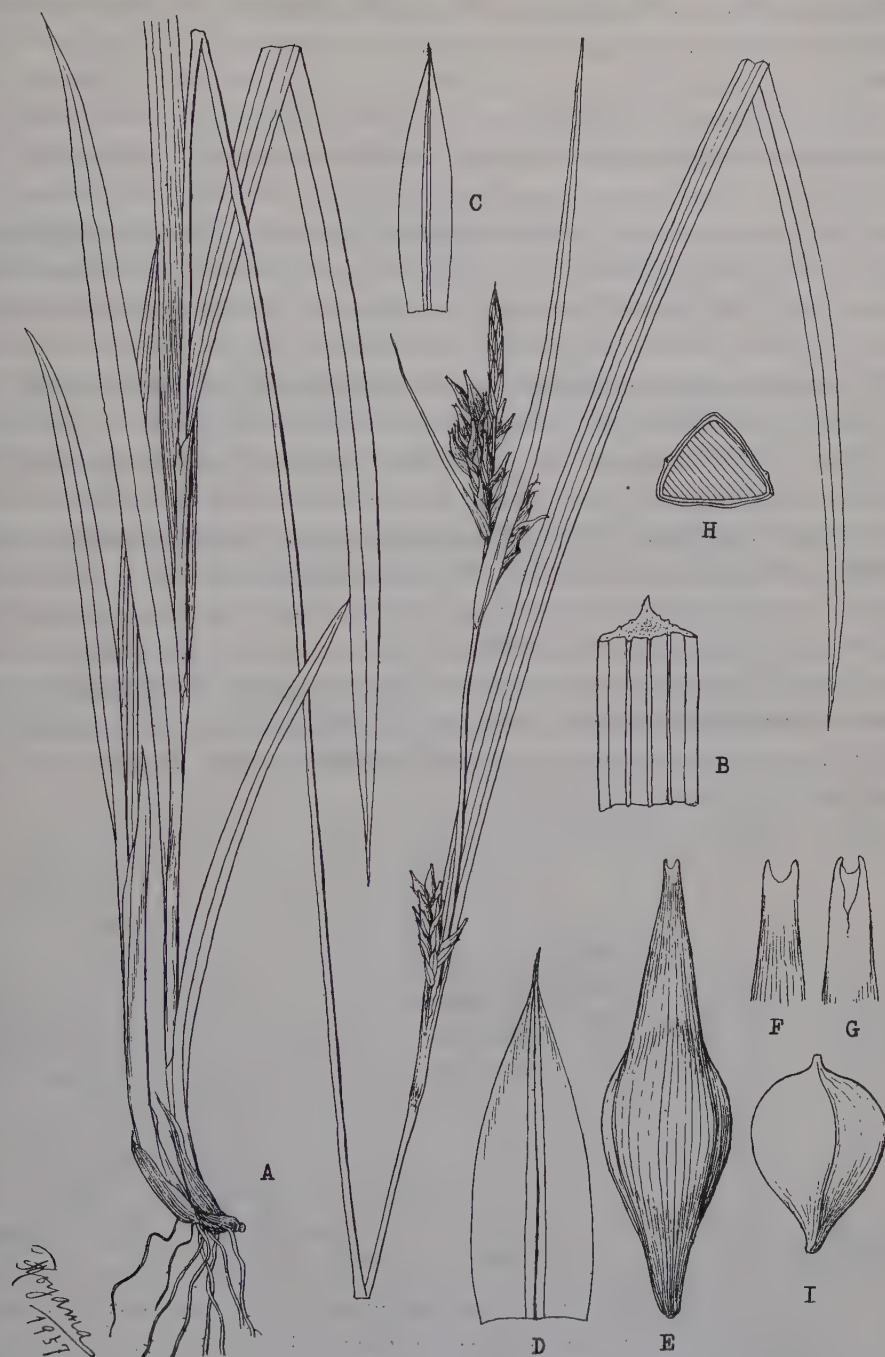


Fig. 10. *Carex Jackiana* Boott — A. Total plant, $\times 3/4$; B. A part of culm; C. Scale of staminate flower, $\times 4$; D. Scale of pistillate flower, $\times 7$; E. Perigynium, $\times 7$; F, G. Dorsal (left) and ventral (right) views of orifice of perigynium; H. Transverse section of perigynium; I. Achene, $\times 7$. (Drawn from Khasia, C. B. Clarke, 43850)

Mr. Nelves, 1953). *C. Jackiana* has also a wide range of variation, in which the Himalayan form is morphologically more closely related to our *C. parciflora* than any other.

Both Dr. Akiyama (1932, 1955) and Dr. Ohwi (1936, 1953) are of opinion that *C. parciflora* is a distinct species from *C. Jackiana*, whereas Dr. Kükenthal (1909) attributed the former to a subspecies of the latter. The difference between these two entities is, in fact, very slight and delicate. After Dr. Kükenthal, *C. parciflora* is distinguished from *C. Jackiana* by its taller culms, broader leaves and smaller perigynia, but these respects are now in the vague in these very polymorphic species. As Fig. 10 shows, *C. Jackiana* from Himalaya, strikingly resembling Japanese *C. macroglossa* (most common form of *C. parciflora*), can be separated from it in having larger staminate spikelet, thicker texture of perigynia and slightly hard culm. On the one hand, as to the distribution, a considerable isolation is noticed between these two. The central and the northern China Proper lies as the interferent region between the areas of *C. Jackiana s. lat.* the former marking its northernmost limit in Yunnan, and the latter not being distributed in the Continent except for *C. macroglossa* of the latter once collected in the southern Korea. *Carex parciflora* seems to have been distributed from a Himalayan prototype to Japan where it must have differentiated to a considerable degree, and another extended to southeast would have been *C. Jackiana* of Indo-Malaysia. I, therefore, treat Japanese *C. parciflora* as a subspecies of *C. Jackiana* laying stress on its much isolated distribution area.

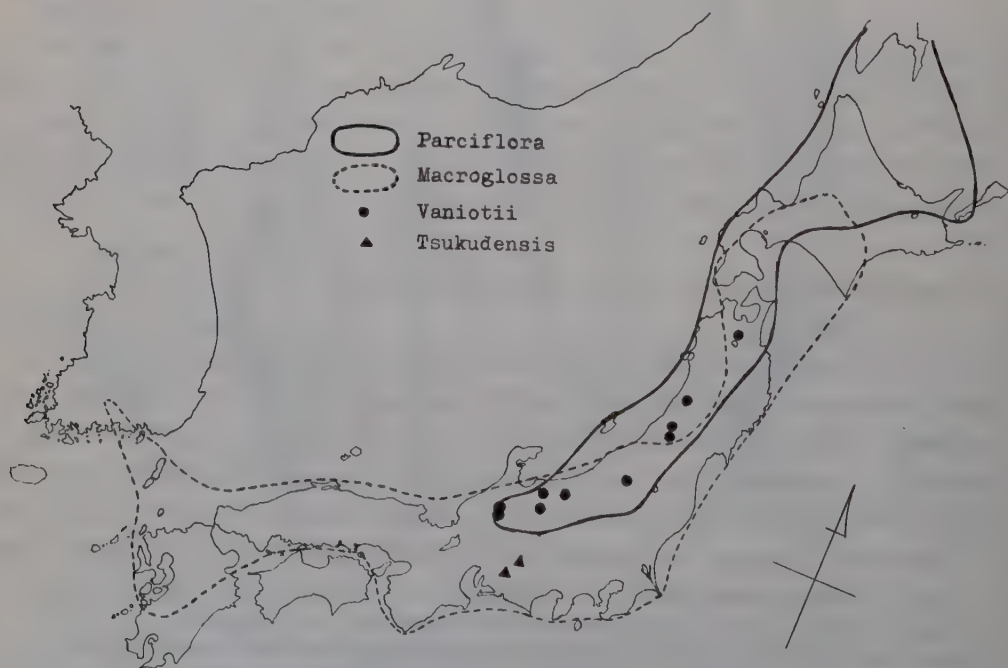


Fig. 11. Distribution of *Carex parciflora* group in Japan.

In Japan, among the variants of *C. parciflora*, the four races, *parciflora*, *macroGLOSSA*, *Vaniotii* and *tsukudensis*, are notable. Each has difference from the others in the perigynium characters mostly accompanied with slight vegetative remarks. These differences are seen in the accounts made by Dr. Akiyama and Dr. Ohwi. I myself will give some additional characters in the nomenclatorial treatment given in the next paragraph. Besides these morphological differences, each of them has somewhat independent distributional area respectively (Fig. 12). *Parciflora* shows what we call the subalpine form. It extends from subalpine region of the central Honshu through Hokkaido to Saghalien and to the southern Kuriles (Is Kunashiri). *Macroglossa* is a lowland member growing in wet forests or sometimes along paddy fields in the southern Hokkaido, Honshu, Kyushu, and southern Korea (Prov. Keinan only). *Vaniotii* belongs to the typical so-called "Hokkoku" Elements or Boreal-Honshu Elements which area is restricted on relatively high mountains on the Japan Sea side of Honshu where the snow is very deep. It occurs from Mt. Hakko-da southwest to Mt. Hakusan. *Tsukudensis*, a local variation on the Mikawa Plateau of the central Honshu, is found in marshy places where some boreal-Japanese plants which would have been brought with the progression of the glacier, still remain in somewhat negative meaning. It is interesting that *tsukudensis* is nearest to *Vaniotii*. These variations are regarded as varieties by Dr. Ohwi (1953) and as species by Dr. Akiyama (1955). Here I agree with the former view considering the relationships between their external characters and distributional areas.

Carex Jackiana Boott in Proc. Linn. Soc. 1: 260 (1945) et in Trans. Linn. Soc. 20: 132 (1846) et Illustr. Carex pt. 1: 9, t. 25 (1858); Kükenthal, Cyper. Caric. 638 (1909); Nelmès in Reinwardtia 1: 384 (1951).

Distrib. India, Ceylon, Malaysia, Australia.

subsp. **parciflora** (Boott) Kükenthal, Cyper. Caric. 638 (1909).

C. parciflora Boott in Mem. Amer. Acad. N. S. 6: 418 (1858-9) — *C. Glehni* F. Schmidt, Reise Amurl. u. Ins. Sachal. 194, t. 7; ff. 16-21 (1868) — *C. Jackiana* Boott var. *parciflora* (Boott) Kükenthal ex Matsumura, Index Pl. Japon. 2-1: 115 (1905).

var. **parciflora** — Fig. 12: G, H.

C. kamikochiana Nakai ex Akiyama in Journ. Fac. Sci. Hokkaido Imp. Univ. Ser. 5, 2: 163 (1932). Nom. Japon. Glehn-Suge.

Distrib. Japan (Honshu, central part and n.-e.-wards; Hokkaido), Kuriles (Is. (Kunashiri), Saghalien).

In this variety, the pistillate scales are more than 2/3 as long as the perigynium and usually acuminate to shortly awned at the apex. Perigynia 4-5.5 mm long. Forma *ochrolepis* (Franchet) Kükenthal, l. c. has sessile staminate spikelets.

var. **macroglossa** (Franch. et Savat.) Kükenthal, Cyper. Caric. 638 (1909) — Fig. 12: B, C.

C. macroglossa Franch. et Savat., Enum. Pl. Japon 2: 148 (1877) et 576 (1879) — *C. Jackiana* Boott var. *macroglossa* (Fr. et Sav.) Kükenthal ex Matsumura, l.

c. 115 (1905) — *C. filipes* Fr. et Sav. var. *oligostachys* Kükenthal, l. c. 641, pro pte. — *C. parciflora* Boott. var. *macroGLOSSA* (Fr. et Sav.) Ohwi in Mem. Coll. Sci. Kyoto Imp. Univ. Ser. B, 5: 290 (1930). Nom. Japan. Kojuzu-Suge.

The size of perigynium varies most markedly in this variety, usually 5-7 mm in length. Scales about half as long as the perigynium or shorter, rather abruptly acute at the apex. The following is a form characterized by very large perigynia (8-9 mm long), subradiately arranged in the apical part of the peduncles always in group of a small number (2-4).

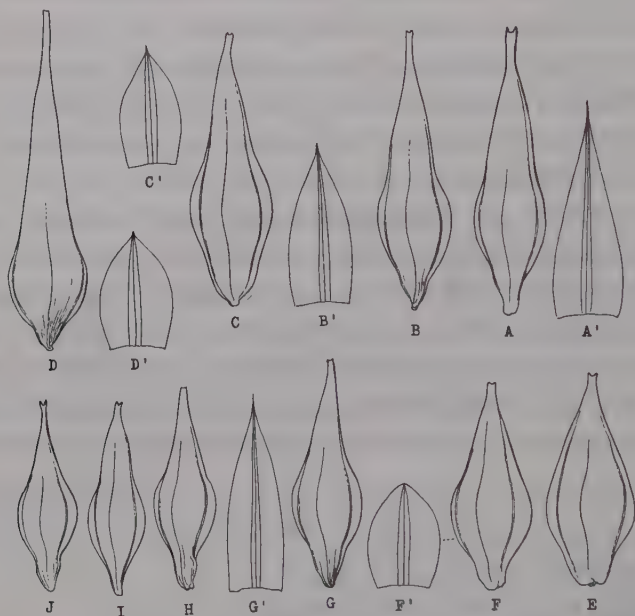


Fig. 12. Perigynia and pistillate scales of *Carex parciflora* and its allies. A: *C. Jackiana*; Khasia, C. B. Clarke 43850—B: *C. parciflora* v. *macroGLOSSA*; Musashi, T. Koyama 387—C: *ibid.*: Niigata, Ikegami 26082—D: *ibid.* forma *subsessilis*; Musashi, T. Koyama 2880—E: *C. p.* var. *tsukudensis*; Ina, Ohmura 17474—F: *ibid.*; Mikawa, T. Koyama 11138-type—G: *C. p.* var. *parciflora*; Kitami, T. Koyama 11080—H: *ibid.*; Ozenuma, T. Koyama 1059—I: *C. p.* var. *Vaniotii*; Uzen, J. Ohwi 5657—J: *ibid.*; Shinano, J. Ohwi 5872. (Icon. orig., all $\times 5$)

forma *subsessilis* (Ohwi) T. Koyama, comb. nova—Fig. 12: D.

C. parciflora Boott var. *macroGLOSSA* Ohwi forma *subsessilis* Ohwi, l. c. 5: 290 (1930) — *C. macroGLOSSA* Fr. et Sav. forma *subsessilis* (Ohwi) Ohwi, l. c. 11: 426 (1936) in descrip. Nom. Japon. Mugi-suge.

Distrib. var. Japan (Hokkaido, Honshu, Kyushu), Korea (Keinan).

van. *Vaniotii* (Léveillé) T. Koyama, comb. nova — Fig. 12 I, J.

C. Vaniotii Léveillé in Bull. Soc. Agric. Sci. et Art. Sarthe 11: 17 (1901) — *C. filipes* Fr. et Sav. var. *Vaniotii* (Lévl.) Kükenthal, Cyper. Caric. 641 (1909) — *C. parciflora* Boott var. *Vaniotii* (Lévl.) Ohwi in Mem. Coll. Sci. Kyoto Imp. Univ. Ser.

B, 5: 290 (1930) — *C. gagaensis* Akiyama in Journ. Fac. Sci. Hokkaido Imp. Univ. Ser. 5, 1: 61, tb. 14 (1931). Nom. Japon. Nagabono-kojuzu-suge, Ao-juzu-suge.

Distrib. Japan (Honshu: Japan Sea side only).

Of all varieties, the perigynia of this variety is the smallest, 4.5-5.5 mm long and 1.5-1.7 mm wide. Plants are wholly yellowish green when living. Growing in forests and fields on mountain but never in peaty moor.

var. *tsukudensis* (T. Koyama) T. Koyama, comb. nova—Fig. 12: E, F.

C. parciflora Boott var. *tsukudensis* T. Koyama in Journ. Jap. Bot. 31: 288 (1956). Nom. Japon. Hirohano-kojuzu-suge.

Distrib. Japan (Honshu: Provs. Mikawa & Shinano).

Short beaked broad perigynia in group of usually 2-5, thickish, short-creeping rhizome, larger ligules and very glaucous colour characterize this variety.

Notes on the Taxonomical Status of *Lophozia diversiloba*

by Hiroshi INOUE*

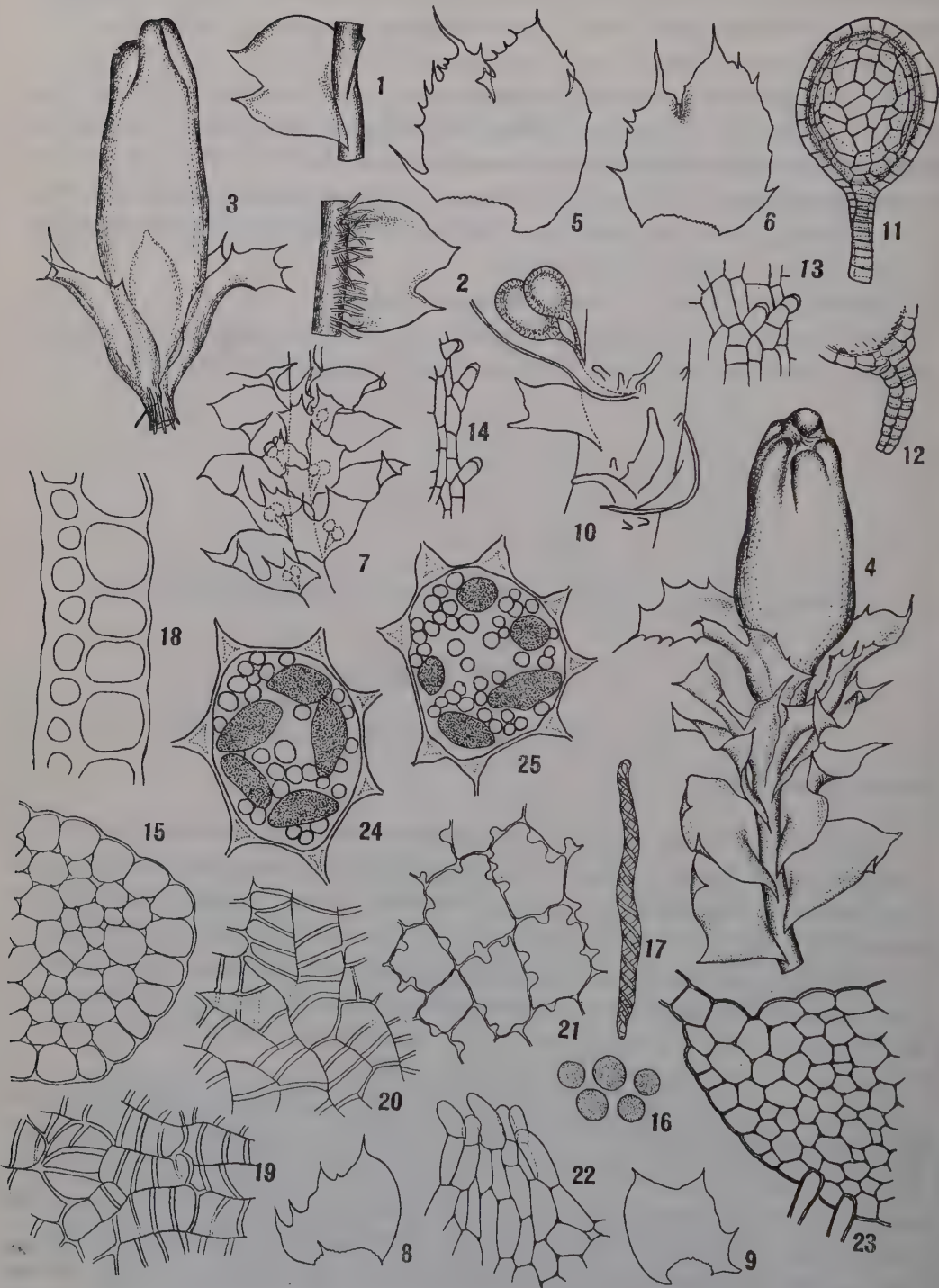
井上 浩*: *Lophozia diversiloba* の分類学上の位置について

Received September 10, 1957

Dr. S. Hattori (1944) described *Lophozia diversiloba* based on the sterile material collected at Mt. Tenso (Tokyo Pref.), and hitherto this species has been reported from only few mountains neighbouring to the type locality. In 1952 Dr. S. Hattori replaced the generic name to *Acrobolbus* without any discussion on his treatment. Dr. S. Hattori's treatment was based on the oil-bodies (S. Hattori in lit.). After the replacement of the generic name, he found the perianth of this species collected by Mr. T. Kodama at Mt. Jumonji, and by the examination of the perianth he referred this species to subg. *Dilophozia* (S. Hattori in lit.).

Last summer the author could collect this species with some young perianths on Mt. Jumonji (Saitama Pref.). The perianth showed marked difference from that of *Acrobolbus*, as that genus was circumscribed in literature. From this collection the male plant and the sporophyte were not available. In July of this year the author collected the plants of this species with fully developed perianths bearing some sporophytes and among the mats of this species many male plants were found. By the

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careful examination on these collections bearing male and female sexual organs and sporophytes, the author concluded that *Lophozia diversiloba* should be the representative of the new subgenus of *Lophozia*, although Dr. S. Hattori (1953) considered this species as a member of subg. *Dilophozia*.

As already described by Dr. S. Hattori (1953) the oil-bodies of *L. diversiloba* are very similar to those of the species of *Acrobolbus* and subg. *Leiocolea* of *Lophozia*. The oil-bodies of *L. diversiloba* are 4-7 (mostly 5) or rarely 2 or up to 13 per cell in number, and the size of them is very variable, as $6-8\mu$ in spherical shape and $10-12 \times 7-9\mu$ to $15-18 \times 7\mu$ in fusiform, and non-homogeneous with numerous granules and grayish in color. The percentage of the spherical oil-bodies becomes gradually larger toward the marginal portion or apex of leaf, and sometimes 1 to 3 large globules can be noticed among numerous granules of the oil-bodies in middle to basal cells of leaf. The type of the oil-bodies of *L. diversiloba* has marked difference from that of subg. *Dilophozia*, in which Dr. R. M. Schuster (1951) described the oil-bodies as "moderately in size (mostly $4-5\mu$), and moderately in number, mostly 8-20, rarely to 25 per cell". In *Acrobolbus* and subg. *Leiocolea* the similar type of the oil-bodies is found, however, the present species has nothing to do with *Acrobolbus* by the perianth, and with subg. *Leiocolea* by the form of perianth, the structure of stem and sporophyte, and the absence of underleaf.

As Dr. S. Hattori considered, this species has close relationships to the members of subg. *Dilophozia* by the following characteristics: the oblique leaf insertion, bilobed leaf, leaf cells with distinct large trigones and the perianth gradually contracted to the plicate to ciliate mouth. If one examines dried and sterile plants of this species, he may refer this species to subg. *Dilophozia* by those characteristics of sterile plant. But, notwithstanding above-mentioned characteristics, *L. diversiloba* has essential differences from subg. *Dilophozia*. As already mentioned above, the small number and the large measurement of the oil-bodies may serve to separate this species from subg. *Dilophozia*. Besides the oil-body the following characteristics of the present species may be regarded as the essential to distinguish from the members of subg. *Dilophozia*: the ciliate-dentate margin of female bracts which bilobed to $1/2$ of length, the capsule wall composed of 2 layers, much modified

Lophozia diversiloba Hatt. 1 Part of plant, dorsal view $\times 14$; 2 Ditto, ventral view $\times 14$; 3 Apical part of plant showing perianth, ventral view $\times 14$; 4 Part of plant with perianth, dorsal view $\times 14$; 5-6 Female bracts $\times 14$; 7 Part of male inflorescence, dorsal view $\times 14$; 8-9 Male bracts $\times 14$; 10 Part of male inflorescence showing two antheridia and some paraphyllia $\times 34$; 11 Antheridium $\times 180$; 12 Antheridial stalk $\times 180$; 13-14 Paraphyllial cells $\times 180$; 15 Part of cross-section of seta $\times 110$; 16 Spores $\times 400$; 17 Elater $\times 400$; 18 Part of cross-section of capsule wall $\times 400$; 19-20 Inner layers of capsule wall $\times 400$; 21 Outer layers of capsule wall $\times 400$; 22 Part of mouth of perianth $\times 110$; 23 Part of cross-section of stem $\times 180$; 24 Cell from basal portion of leaf showing oil-bodies and chloroplasts $\times 1000$; 25 Ditto from middle portion of leaf $\times 1000$. All figures are based on living material collected on Mt. Shiroya; in July of this year.

male bracts which lobed into 3-5 and the dorsal insertion which is nearly transverse to oblique, the presence of minute 1-4 celled (or sometimes more, in irregular shape) paraphyllia among male bracts, and lacking the ability to produce gemmae.

Dr. R. M. Schuster (1951) stated the close relationships among the subgenera *Massula*, *Isopaches* and *Dilophozia*. Of them especially to *Isopaches* the present species has close relationship in some ways, as in the spore-elater ratio, biseriate antheridial stalk, ciliate-dentate margin of female bracts and bilobed leaf. *Isopaches* was treated as a distinct genus (K. Mueller 1954, Frye and Clark 1944) or subgenus of *Lophozia* (R. M. Schuster 1951, 1953). According to the descriptions by European bryologists, the capsule wall of *Isopaches* is composed of 2 layers of nearly equal-sized cells, and the inner wall has semiannual thickenings. The capsule wall of *L. diversiloba*, however, is 2 layers of anisodiametric cells and the inner wall has complete annual thickenings. The structure of the capsule wall, the presence of paraphyllia in male bracts and the lack of ability to produce gemmae serve to separate this species from *Isopaches*.¹⁾ From *Massula* the present species may be easily distinguishable by the characteristics of the oil-bodies, the lack of gemmae, the structure of capsule wall, and the presence of paraphyllia in male bracts.

The presence of the paraphyllia among male bracts may indicate the some relationship to subg. *Orthocaulis*²⁾ (but it is not all species of this subgenus). From subg. *Orthocaulis* the present species may be easily separable by the different structure of stem, always (or nearly so) bilobed leaves, and the lack of underleaves and gemmae.

From the above discussions the author concluded to propose a new monotypic subgenus of *Lophozia* for *L. diversiloba*. The circumscription of the subgenus is as follows, and the subgeneric name is in honor of Dr. S. Hattori who first described this species and gave me many suggestive advices.

Lophozia Dumotier subgenus *Hattoriella* Inoue, subg. nov.

Affinis *Dilophoziae*, sed distinguenda: folia floralia feminea ciliato-dentata; oleicorpora 4-7 per cellulam; gemmae nullae; peduncula antheridii biseriata; praesentia in inflorescentis masculis.

Plants moderately large, about 2.5 cm long, decumbent with ascending apices. Stem 14-17 cells high at maturity; in cross-section hardly showing dorsiventral differentiation, medullar cell-walls thin throughout with small trigones, cortical cells similar to medullary cells but with slightly thicker walls. Rhizoids numerous, long. Leaves obliquely inserted, spreading to oblique and loosely imbricate, nearly always bilobed

1) In regard to the structure of the seta of *Isopaches* Frye and Clark (1944) noted as "with a central group of 4 cells surrounded by a circle of 8 cells, and sometimes by a second of 8 cells", and R. M. Schuster (1951) stated as "upto 21 outer cell-rows". In this regard *L. diversiloba* has more thicker seta and has distinct trigones in cross-section, and differs from *Dilophozia*, *Isopaches* and *Massula*.

2) R. M. Schuster (1953) figured the paraphyllia in *L. (Orthocaulis) quadriloba*, but he did not mention on this characteristic feature in his revision of Lophoziaceae (R. M. Schuster 1951).

without cilia in basal portion, entire throughout.¹⁾ Cells with distinctly large trigones, $30-37 \times 27-33 \mu$ in leaf middle, thin-walled, cuticle faintly papillose.²⁾ Underleaves completely lacking. Dioecious. Pericaetial bracts with ciliate-dentate margin, bilobed about $1/2$ of length, larger than leaves. Bracteole lacking. Perianth completely free from bracts, plicate in upper $1/3$, with ciliate mouth. Seta with many rows of cells, cells of epidermal layer 24-28. Capsule wall composed of 2 layers, inner layer with complete tangential-radial thickenings and outer layer with radial thickenings; in cross-section inner cells about $13 \times 13 \mu$, outer cells $16-27 \times 27 \mu$. Spore-elater ratio approximately 1.2:1. Male bracts inserted with line of insertion which is dorsally transverse to oblique, 3-5 lobed, with paraphyllia (irregular in shape) from axis of, or near bracts. Antheridia usually 2 per bract (near apex or base of inflorescence usually single). Antheridial stalk always biseriate. Gemmae absent.

Type: *Lophozia diversiloba* Hatt. (Jour. Jap. Bot. 20: 265. 1944)

Phylogenetically, as already discussed above, present subgenus has the closest relationship to subg. *Isopaches*. Phylogenetic key to subgenera related to this subgenus will be shown in summary. The allied species to *L. diversiloba* cannot be found among the species distributing in arctic or subalpine region. They may be found among the species distributed in high mountaineous zone (alpine or subalpine area) of subtropics, such as *L. morrisonicola* Horikawa, known from Formosa, which was described in sterile condition.

L. diversiloba is, at present, distributed restrictedly in calcareous region belonging to the Palaeozoic, and the present species can be regarded as a representative liverwort of calcareous flora. This species grows on bared and humid limestone or on thin layer soil covering limestone, forming compact mats. Only three mountains are known as the locality; Mt. Tenso (type loc.), Mt. Jûmonji and Mt. Shiroya (Saitama Pref.). In all localities cited above the present species grows mingled with *Preissia quadrata*, *Conocephalum conicum* and *Plagiochasma intermedium*, and rarely on Mt. Shiroya with *Acrobolbus mayebarae*. The ecological sites noted above situated in the coniferous forest zone, up to 2000 m above sea level.

Summary

In the present paper the author proposed a new subgenus of *Lophozia* Dum., *Hattoriella*, including a single species, *L. diversiloba* Hatt., and the relationships to other subgenera are discussed. Key to those subgenera may be as follows:

Underleaves present; cortical cells of stem with distinctly thickened walls; oil-

1) Rarely 1-2 marginal teeth are observed in the leaves near apical portion of sterile shoot. In fertile shoot those teeth are usually observed in leaves following to bracts.

2) S. Hattori (1944, 1953) noted the "pale yellowish-brown color of trigones as a distinct feature of *L. diversiloba*. In living plants, however, this color of trigones is not distinct, and it is usually white. Furthermore, the cuticle is faintly papillose but in dried plants it is rather obscure (he did not allude to this cuticular feature in his original description.)

bodies rather few in number and large in size; capsule wall composed of 3-5 layers; gemmae present; paraphyllia usually not present in male inflorescence ... *Orthocaulis* and *Leiocolea*

Underleaves not present; cortical cells of stem not so thickened; oil bodies few in number and large in size; capsule wall composed of 2 layers of anisodiametric cells; gemmae not present; paraphyllia present in male inflorescence ... *Hattoriella*

Underleaves not present; cortical cells of stem not thickened; oil-bodies many in number and small in size; capsule wall composed of 3-5 or 2 (in *Isopaches*, isodiametric cells) layers; gemmae present; paraphyllia not present in male inflorescence ... *Dilophozia*, *Isopaches* and *Massula*.

The author should like to express his hearty thanks to Dr. S. Hattori, the director of the Hattori Botanical Laboratory, for his many suggestive advices and criticisms. He must also acknowledge to Prof. H. Ito of our University for his cautious guidance through the author's bryological works.

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Identification of Growth Inhibitors in *Helianthus* Leaves*

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柴岡弘郎**・今関英雅**: ヒマワリの葉に含まれている生長阻害物質

Received September 26, 1957

Introduction

Growth substances in plant materials have been investigated using chromatographical technique combined with Salkowski's color reaction and bioassay method (cited in 3). Experiments have demonstrated the occurrence of not only auxins but also of growth inhibitors in many plant species and various plant tissues (2, 7, 8, 9, 10, 11 and 12). Konishi (8), K. Koshimizu and Mitsui (9), and T. Koshimizu and Hiraiwa (10) also showed that an auxin existing in plant tissues, which was regarded

* 本研究の一部は文部省科学研究費(総合研究課題番号 4072)を用いて行われた。

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as IAA for its Rf value, never gave color reaction with Salkowski's reagent. This lack of color reaction might be due to a certain substance inhibiting Salkowski's color reaction. Though many authors demonstrated the occurrence of growth inhibitors and suggested the existence of color development inhibitors as mentioned above, the nature of these two groups of inhibitors and the relationship between them have not yet been determined.

The authors have been studying the nature of heliotropism of young seedlings of *Helianthus annuus* and have discovered the existence of growth inhibitors and inhibitors of development of color reaction of IAA with Salkowski's reagent. The authors determined the nature of two of the color reaction inhibitors and studied their growth inhibitory effect in presence of IAA.

Materials and Methods

Helianthus annuus L. (variety "Large-Russian") were grown in a green house in flat boxes. When the height reached 20-25 cm, their upper 4 leaves were cut off and used for this study.

Extraction: The extract to be subjected to paper chromatographical analysis was prepared as follows: 10 g of fresh materials was chopped and extracted with about 100 ml of boiling ethanol (80 %) for 5 minutes. The ethanolic extract, after being filtered with filter paper, was concentrated under reduced pressure to about 10 ml, filtered through celite pad, and the filtrate was further concentrated to about 1 ml.

Paper Chromatography: Whatmann No. 1 and Toyo No. 50 filter paper strips were used and ascending method was applied. As developing solvent systems, following mixtures were used: n-butanol-acetic acid-water (4:1:2 v/v), 70 % ethanol, n-butanol saturated with water, 80 % phenol, ethylacetate-formic acid-water (10:2:3 v/v) (16) and isopropanol-water-ammonia (10:1:1 v/v).

Ultraviolet Absorption Spectrum: The sample was prepared by eluting with water from a chromatogram run with butanol-acetic acid system, i. e. band of phenolic substance was cut out from the chromatogram under ultraviolet light and extracted with water. Optical densities of the water eluate were determined using a Beckman Model D. U. spectrophotometer.

Bioassay: The chromatogram containing the extract which represents 4 g of *Helianthus* leaves in fresh weight was divided into 18 pieces according to the fluorescence pattern, and each division was eluted in 10 ml of 2 per cent sucrose solution with 10 μ g of IAA. The biological activity of each eluate was measured by *Avena* straight growth method. For this method, *Avena* seedlings were grown at 25°C in the dark, and 3 hours after decapitation, 5 mm sections were cut from the decapitated coleoptiles, floated on 10 ml test solution, and their length measured after 18 hour incubation at 25°C in the dark.

Hydrolysis: The eluate from the chromatogram was added to an equal volume of 1 N KOH, and the mixture was heated on a boiling water bath for 15 minutes. Then,

the hydrolysate was acidified with 10 per cent acetic acid and fractionated with ether.

Authentic Specimens: Chlorogenic acid (mp 202-204°C) was isolated from green coffee beans (Java) by Uritani and Matsumura's method (18). Isochlorogenic acid was obtained as crude powder from coffee beans by Barnes et al's method (1). Caffeic and quinic acid were obtained by alkaline hydrolysis of chlorogenic acid.

Results

The existence of growth inhibitors and color development inhibitors.

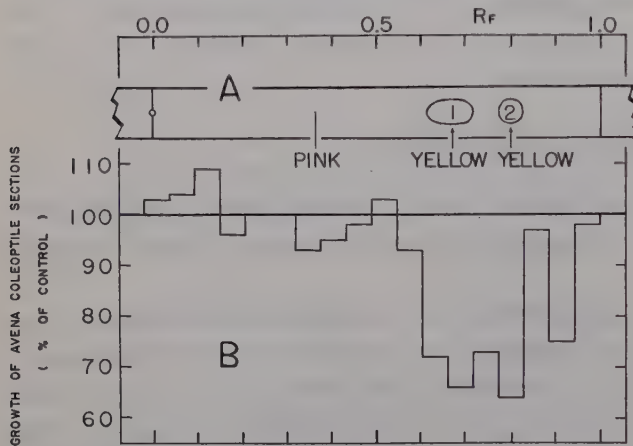


Fig. 1 Chromatograms of ethanolic extract of *Helianthus* leaves, developed in 70 % ethanol.

- A: Tested with Salkowski-Link's reagent after spraying with IAA solution.
 B: Assayed in *Avena* straight growth method. Elongation of *Avena* coleoptile sections in eluates from the divided chromatogram containing 1 mg/l IAA and 2 % sucrose. Eluates from the corresponding parts of a blank chromatogram were used as control of this experiment.

The results of the bioassay of plant extract chromatogram are shown in Fig. 1 B. There are three growth inhibiting zones (Rf 0.60-0.72, Rf 0.74-0.83 and Rf 0.88-0.94, 70 % ethanol) on a chromatogram. To detect the color development inhibitors, dried chromatograms were tested with Salkowski-Link's reagent (0.1 % FeCl_3 : 20 % HCl , 1: 1 v/v) (20) after spraying with IAA solution in concentration of 300 mg/l. Then, the two yellow spots which resulted from the lack of Salkowski's reaction (Rf 0.63-0.72 and Rf 0.77-0.83, 70 % ethanol) appeared on the pink background (Fig.

1A). These two spots corresponded to the lower two growth inhibiting zones on the chromatogram of Fig. 1B. If the chromatogram was exposed to ultraviolet light, two spots of strong fluorescence were observed above Rf 0.6 of the chromatogram. These two spots always correspond to the two growth inhibiting zones of Fig. 1B and also to the two yellow spots of Fig. 1A.

The identification of growth inhibitors and color development inhibitors.

These substances gave green color with ferric chloride, this phenomenon suggests that these two substances were ortho-dihydroxy phenols. The chromatographical behaviors and color reactions of spot 1 and 2 were greatly similar to those of chlorogenic and isochlorogenic acid (an isomer of chlorogenic acid), respectively

Table 1

Solvent	A. Rf values of growth inhibitors			
	Rf value			
	Spot 1	Spot 2	Chlorogenic acid	Isochlorogenic acid
BuOH-AcOH-H ₂ O	0.58	0.75	0.58	0.77
Ethanol	0.65	0.80	0.67	0.82
Phenol-Water	0.18-0.32	0.18-0.32	0.22-0.35	0.19-0.34
Butanol-Water	0.10-0.25	0.10-0.25	0.10-0.25	0.10-0.25

Reagent	B. Color reactions of growth inhibitors			
	Color reaction			
	Spot 1	Spot 2	Chlorogenic acid	Isochlorogenic acid
FeCl ₃	green	green	green	green
NH ₃ -vapour	yellow	yellow	yellow	yellow
UV-fluorescence	blue	blue	blue	blue
UV-fluorescence with NH ₃	greenish blue	greenish blue	greenish blue	greenish blue
Höpfner's	orange	orange	orange	orange

(Table 1). Ultraviolet absorption spectra of the two spots were quite the same with that of chlorogenic acid (Fig. 2). Uritani and Miyano (19) compared the UV-spectrum of chlorogenic acid with that of its isomers, and showed a close resemblance in the UV-absorption spectra between chlorogenic acid and its isomers. So the absorption spectra of the eluates of the two spots of Fig. 1 and that of chlorogenic acid show that spot 1 and 2 are chlorogenic and isochlorogenic acid, respectively.

Under alkaline hydrolysis of the eluates of the spots, caffeic acid was detected in the ether soluble fraction of respective hydrolysate; and quinic acid was found in the ether insoluble fractions (Table 2). Caffeic acid was easily determined by its characteristic color reaction with Höpfner's reagent yielding red color. Quinic acid was detected by spraying with B. C. G. indicator or with potassium permanganate solution (4). It was thus demonstrated that both of the two spots in question consisted of caffeic and quinic acid.

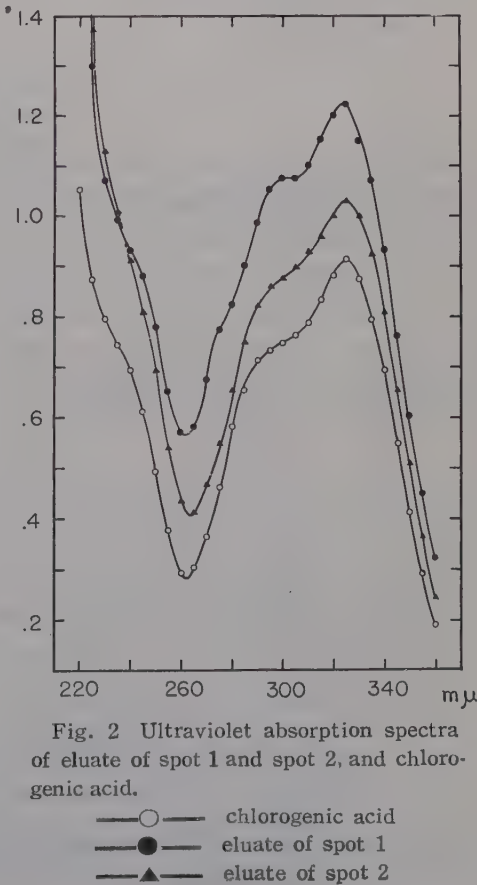


Fig. 2 Ultraviolet absorption spectra of eluate of spot 1 and spot 2, and chlorogenic acid.

Based on the data obtained, the authors confirmed that spot 1 and spot 2 were chlorogenic acid and isochlorogenic acid, respectively.

The effects of chlorogenic acid on *Avena* coleoptile and Salkowski's reaction.

The effects of chlorogenic acid on *Avena* straight growth are shown in Fig. 3 and Fig. 4. Fig. 3 shows the straight growth of *Avena* coleoptile sections in different concentration of chlorogenic acid, in the presence of 2 per cent sucrose and 1 mg/1

Table 2
Rf values and color reactions of hydrolysate of growth inhibitors

Solvent	Ether soluble fraction of hydrolysate of		Caffeic acid
	Spot 1	Spot 2	
BuOH-AcOH-H ₂ O	0.86	0.86	0.87
Ethylacetate-Formic acid	0.93	0.93	0.94
Phenol-Water	0.48	0.47	0.49
Reagent			
FeCl ₃	green	green	green
UV-fluorescence	blue	blue	blue
UV-fluorescence with NH ₃	blue	blue	blue
Höpfner's reagent	red	red	red

Solvent	Ether insoluble fraction of hydrolysate of		Quinic acid
	Spot 1	Spot 2	
BuOH-AcOH-H ₂ O	0.39	0.38	0.36
Ethylacetate-Formic acid	0.10	0.12	0.10
Phenol-Water	0.20	0.20	0.18

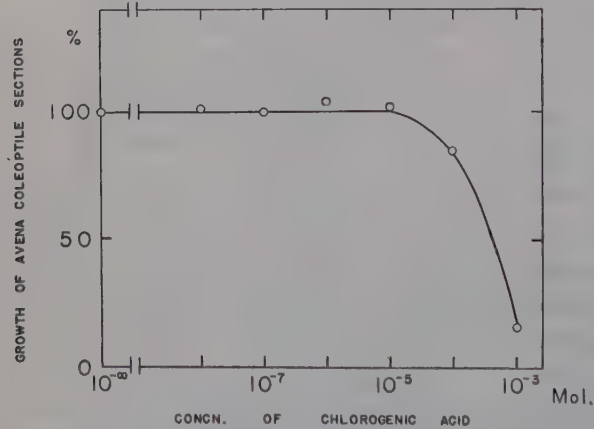


Fig. 3 Elongation of *Avena* coleoptile sections in 2% sucrose with IAA of 1mg/1 and different concentration of chlorogenic acid. Growth was measured after 18 hr. at 25°C and is expressed as per cent of that in absence of chlorogenic acid.

IAA. And Fig. 4 shows the results of similar experiments in the absence of IAA. As shown in Fig. 3 and Fig. 4, when IAA is present, chlorogenic acid shows only inhibiting action on growth, while, in the absence of IAA, it causes an obvious growth promotion at 10⁻⁴M. As the growth curve of *Avena* coleoptile sections in different concentration of chlorogenic acid, shown in Fig. 4 closely resembled that of the accelerator-α of Bennet-Clark and Kefford (2), chlorogenic

acid was developed with isopropanol-water-ammonia, the same solvent that has been used for investigation of the accelerator- α . (If developed quantity is extremely small, its R_f value becomes strictly 0.0.)

Using Salkowski-Tang's reagent (0.5 M FeCl_3 : H_2O : H_2SO_4 , 15: 500: 300 v/v) (17), the effects of chlorogenic acid on color reaction was studied. The reagent was added to 15 mg/l IAA solution containing various amounts of chlorogenic acid, and the color densities were measured after 30 minutes using photo-electric photometer with green filter. As shown in Table 3, chlorogenic acid at a concentration of 10^{-3} M decreases the color development of IAA by approximately three-fourths.

Caffeic acid and catechol (13) have the same activity as chlorogenic acid on Salkowski's color reaction of IAA, and DOPA and protocatechuic acid have a low activity on the inhibition of the color reaction.

Discussion

As the results of this investigation, three growth inhibitors were detected in *Helianthus* leaves, and two among these three inhibitors were identified as chlorogenic acid and isochlorogenic acid. By comparison of R_f values, these two substances correspond to the inhibitors reported by Konishi in shoots of *Silene* and spinach (R_f 0.5-0.6, 70 % ethanol) (8), by K. Koshimizu and Mitsui in bamboo shoots (R_f approx. 0.65, 70 % ethanol) (9) and by T. Koshimizu and Hiraiwa in dormant axillary bud of *Nandina domestica* (R_f 0.5-0.7, 70 % ethanol) (10), but not to the inhibitor- β of Bennet-Clark and Kefford (2). The positions of chlorogenic and isochlorogenic acid on chromatogram correspond to that of the accelerator- α rather than to that of the inhibitor- β . Moreover, the growth curve of *Avena* coleoptile sections in solutions containing different concentration of chlorogenic acid, in the absence of IAA, resembles that of the accelerator- α , so it seems that chlorogenic acid or its isomer is the accelerator- α itself. This assumption is confirmed by the occurrence of the accelerator- α (7) and chlorogenic acid (14) in the same material, namely etiolated sunflower

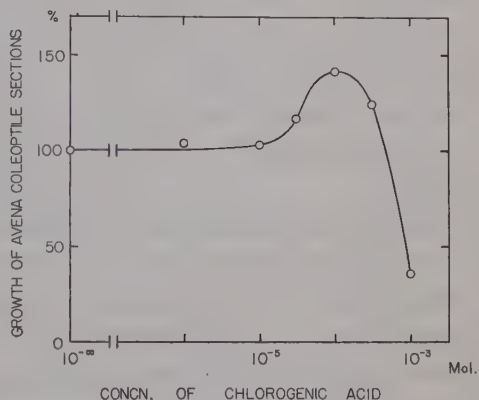


Fig. 4 Similar to Fig. 3, but IAA is not added to the medium.

Table 3

Effect of chlorogenic acid on color reaction with Salkowski-Tang's reagent.

Concn. of chlorogenic acid in 15 mg/l IAA solution	Decreased color densities in %
0.0 M	0.0
10^{-6}	0.0
10^{-5}	5.0
10^{-4}	25.5
10^{-3}	76.0

seedling. Chlorogenic acid changes the acidity of the medium of *Avena* straight growth test, and the effect of chlorogenic acid on growth of coleoptile sections seems to depend on its effect on changing the pH of test solution.

Caffeic acid, a hydrolysed product of chlorogenic acid, however, inhibits the growth of coleoptile in high concentration (10^{-4} – 10^{-3} M) in wide range of pH values. This inhibitory effect of caffeic acid, the wide distribution of chlorogenic acid in plants (5, 6, 14, 15 and 16) and the probable occurrence of this acid in dormant bud of *Nandina domestica* (10) let the authors have an idea that chlorogenic acid has some role on growth inhibition of plants in general. The physiological effect of chlorogenic acid on plant growth in relation to that of caffeic acid will be reported later.

It was also proved that in *Helianthus* leaves there were two substances which inhibit Salkowski's color development. The presence of such substances in plant tissues makes caution necessary in studies of plant growth hormones especially the identification of IAA extracted from plant materials and the estimation of IAA-oxidase activity of tissue sections using Salkowski's reagent.

Summary

This study was made to demonstrate the relationship between certain growth inhibitors and Salkowski's color reaction inhibitors, and to identify these substances.

1) In ethanolic extract of *Helianthus* leaves, there are three substances which inhibit the IAA induced growth of *Avena* coleoptile sections.

2) Two of them also inhibit Salkowski's color reaction of IAA.

3) These two substances were identified with chlorogenic and isochlorogenic acid, respectively.

4) Chlorogenic acid inhibits, at 10^{-4} – 10^{-3} M, the IAA induced growth of *Avena* coleoptile and, in concentration of 10^{-4} M, promotes the elongation in absence of IAA.

5) These effects of chlorogenic acid on growth seem to depend on the change of pH of the test solution due to the addition of different concentration of the acid. But the facts that caffeic acid has an inhibitory effect on growth and the probable occurrence of chlorogenic acid in dormant bud, let the authors have an idea that chlorogenic acid has some role on growth of plant.

6) Chlorogenic acid decreases Salkowski's color development.

7) The growth curve of *Avena* coleoptile sections in solutions containing various concentration of chlorogenic acid and the Rf value of chlorogenic acid resemble those of the accelerator- α of Bennet-Clark and Kefford.

The authors wish to express their gratitude to Ass. Prof. T. Yamaki of the University of Tokyo for his leadership during the investigations. Also grateful acknowledgments are made to Prof. S. Hattori and Prof. M. Monsi of the University of Tokyo who gave the authors helpful advice.

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Flower Initiation of the Spring Wheat in Total Darkness

by Mamoru SUGINO*

杉野 守*: 全暗黒条件における春小麦の花芽分化

Received September 27, 1957

It has been reported that several plants can initiate flower primordia when cultured in total darkness. To such plants belong not only some short-day plants,^{12,13)} but also many long-day plants such as *Spinacia oleracea*, *Pisum sativum*, *Raphanus sativus*, *Baeria gracilis*, *Rudbeckia bicolor* and *Silene Armeria*.^{6,11,13)}

The present experiments were performed with aims to examine the effects of nutritional conditions upon the growth and development of wheat plants in aseptic culture in test tubes and to test the possibility of flower initiation in total darkness.

Materials and Methods

One of the most early-flowering varieties of spring wheat, Konosu No. 25, was used for the present study on account of its short life cycle. In a preliminary experiment, it was observed that the plant initiates visible ear primordia two weeks after germination under continuous illumination.

The basic culture medium was the modified White's solution. It contains: $\text{Ca}(\text{NO}_3)_2$ -200mg, Mg SO_4 -360mg, Na_2SO_4 -200mg, KNO_3 -80mg, KCl -65mg, $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ -16.5mg, MnSO_4 -4.5mg, ZnSO_4 -1.5mg, KI -0.75mg, Fe-citrate -4mg, Ebios -500mg, Agar -8g and distilled water 1000ml. Five groups of the culture media which contained 0, 2, 4, 8 and 10 per cent sucrose of chemical grade respectively were prepared. About 10ml of the culture medium was poured into an 18×150mm test tube and autoclaved

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at 1.6 atm for 20 minutes. Initial pH was adjusted to 5.6-5.8 with 0.1 N KOH.

For the sterilization, seeds were 1) soaked in cresol-water 1:10 solution for 5 minutes, 2) washed in distilled water several times, 3) soaked in 75 per cent alcohol for 5 minutes, 4) soaked in 10 per cent solution of chlorinated lime for 30 minutes and 5) washed in sterilized distilled water several times until the smell of chlorine disappeared in the waste water.

Experiments were started on October 8, 1955. Two grains of the seed were aseptically sown in each test tube and were grown under three light conditions: total darkness, 8-hour short-day and continuous light. The sources of artificial light consisted of four 100 watt incandescent lamps and one 20 watt daylight fluorescent lamp, the luminosity at the plant level being about 1000 lux. In the daytime, they were supplemented with diffused daylight which had about one fiftieth of natural daylight intensity. All cultures were placed in a room kept at $20 \pm 2^\circ\text{C}$.

The observations were carried out 50 days after germination in the long-day series, 56 days in the short-day series and 108 days in the dark series, when the flower primordia were recognizable.

The flowering stage and number of leaves produced on the shoot were observed under a binocular microscope. The former was recorded according to the arbitrary scale given in Table I. The leaf number of tillers, which were often produced in the dark culture, is the sum of the number of the leaves on tiller itself and that on the main shoot up to the node on which the tiller branched.

The dry weights of the plants were measured about one week after harvest when the materials attained constant weight in a desiccator after having been killed in an electric oven at 110°C .

Table I. Values assigned to stages in development of the flower primordia

Values	Description of the shoot apex
0	Vegetative, smooth dome
0.5	Slightly elongated apex
1	Elongated phalloid apex
2	Double ridge
3	Formation of side spikelet
4	Anther initials visible
5	Heading

Table II. Culture of Konosu No. 25 under continuous illumination, from October 9 to November 28, 1955

Sucrose concns.	0%	2%	4%	8%	10%
No. of plants observed	29	20	14	20	30
No. of plants with flower	29	20	14	20	30
Leaf number	5.27 ± 0.08	5.08 ± 0.05	5.13 ± 0.09	5.17 ± 0.08	5.09 ± 0.06
Flowering stage	4.29 ± 0.11	4.39 ± 0.11	4.90 ± 0.03	4.90 ± 0.06	4.88 ± 0.06
Stem length in mm	117.8 ± 6.05	162.0 ± 4.89	155.7 ± 5.55	167.3 ± 6.39	158.8 ± 5.49
Fresh weight in mg	154.8	151.5	146.4	150.0	145.9
Dry weight in mg	24.2 ± 0.70	35.5 ± 1.65	46.1 ± 1.79	60.3 ± 1.85	60.0 ± 2.31

Table III. Culture of Konosu No. 25 in short days,
from October 9 to December 4, 1955

Sucrose concns.	0%	2%	4%	8%	10%
No. of plants observed	19	25	29	19	24
No. of plants with flower	3	25	29	19	24
Leaf number	8.00*	6.76±0.12	6.97±0.11	7.31±0.15	6.79±0.15
Flowering stage	0.5±0.00	2.78±0.07	3.04±0.07	2.77±0.11	2.84±0.16
Stem length in mm	3.2±0.67	89.2 ±3.81	95.6 ±3.15	97.1 ±5.38	87.3 ±2.45
Fresh weight in mg	111.2	125.0	152.4	161.9	151.3
Dry weight in mg	18.5±1.05	33.1 ±1.38	45.2 ±1.53	55.4 ±2.15	56.3 ±1.69

* The leaf number of plants with flower

Table IV. Culture of Konosu No. 25 in darkness,
from October 9, 1955 to January 25, 1956

Sucrose concns.	0%	2%	4%	8%	10%
No. of plants observed	10	29	32	22	30
No. of plants survived	0	(2)	20	20	23
Survival percentage	0	(6.9)	62.5	90.9	76.6
No. of plants with flower	—	0	7	16	17
% of flowering plants against survivals	—	0	35	80	77.3
Leaf number in flowering stem	—	—	10.42±0.20	10.38±0.15	10.35±0.26
Flowering stage	—	—	0.50±0.00	0.69±0.06	0.76±0.09
No. of tillers developed per survival	0	0	0.9	1.0	1.0
No. of leaves per live stem	—	(11.0)	10.1	10.3	10.3
dead stem	5.5	6.6	7.4	7.0	7.2
Length of live stem	—	(545.0)	207.7±20.0	156.0± 9.6	196.1±16.4
dead stem	180.0±17.9	313.4±14.0	267.0±10.3	222.8±14.6	218.5±13.2
Fresh weight of live plant	—	(209.0)	176.5	146.6	134.0
Dry weight of live plant	—	(41.0)	46.5±2.20	48.7±2.99	54.4± 3.67
dead plant	15.6	30.2	32.5	29.0	34.0

(): Plants were partly imbedded in agar medium.

Results

The results are represented in Tables II, III, IV and V.

1) Generally, the wheat plants developed in the test tube were very small in size as compared with the normal plants grown in the field. This apparently "adaptive" growth is probably due to the limited supply of food materials, since in sand culture without fertilizer the plant developed also much smaller size than the normal.

The growth of the wheat plant in the test tube depended largely on light conditions and also on sucrose content of the culture medium. Under continuous illumination, all plants grew fairly well and developed flowers even on the medium without sucrose, whereas in short days all plants grew meagerly and only 3 out of 19 plants could initiate flower primordia on the sugarless medium. In the dark, no

plants could survive without sugar, and on the medium containing the lowest concentration (2%) of sucrose, were alive only two plants whose shoots were partly imbedded in the medium.

2) Stem lengths of the plants cultured under continuous light or short-day conditions were nearly the same irrespective of the sucrose concentrations ranging from 2 to 10 per cent in the media, although those cultured on the medium without sucrose showed markedly small values (Tables II and III).

Under continuous darkness, stems were elongated markedly and showed an etiolated appearance, but their growth seems to be restricted to a certain limit (Table IV). The tops of main axes in the dark-grown plants were almost dead after having reached this limit, and on the media containing more than 4 per cent sucrose, tillers developed. On sugarless media, the shoots elongated up to 180 mm and were all dead, probably due to the exhaustion of reserve materials. In the presence of sucrose in the medium, further but limited stem elongation could occur, a maximum value of 313 mm being attained on the 2 per cent sucrose medium. The length and the number of dead stems and dry weight of dead plants had nearly the same limited values except the lower value on the sugarless medium.

3) Fresh weight was not varied remarkably with sucrose concentrations in long days, but it showed relatively lower values on media without and with 2 per cent sucrose in short days. It is remarkable that the fresh weight of the dark grown plants decreased with increasing sucrose concentrations.

Dry weight was greatly affected by the sucrose added. With increasing sucrose concentrations, the dry weight of plants increased under all light conditions.

4) Number of leaves formed on the axis before flowering was not so much affected by sucrose concentrations either in long or short days, although a somewhat higher value was obtained on the sugarless medium. In the darkgrown plants, the leaf numbers were nearly equal on the media with more than 4 per cent sucrose.

5) Flowering stage was not varied by sucrose concentrations in long days. In short days somewhat lower value was obtained in the series without sucrose. In the dark culture, although the development of flower primordia was slow and poor, a gradual increase in flowering stages was observed with increasing sucrose concentrations. The details of flower development in darkness are represented in Table V.

Table V. Development of flower primordia in the dark culture
a. Observation 103 days after inoculation

% of sucrose in media	Values*1								
	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	Mean
0	—	—	—	—	—	—	—	—	—
2	0	0	0	0	0	0	0	0	0
4	7	0	0	0	0	0	0	0	0.5±0.00
8	11	4	1	0	0	0	0	0	0.69±0.06
10	11	3	2	1	0	0	0	0	0.76±0.09

b. Observation 135 days after germination*2

10	9	8	2	0	0	2	2	0	1.29±0.23
10*3	3	0	5	2	8	2	1	0	2.05±0.19

*1 See Table I

*2 Experiment performed with the aims to test the effects of phosphate on flower initiation,

*3 Medium contained 5 times phosphate in excess.

Discussion and Conclusion

The growth and development of wheat plants are accelerated by light.¹⁾⁻⁴⁾ The longer the day length is, the faster the plant grows. This is probably due, at least in part, to the increased photosynthesis as pointed out by Pohjakallio.⁷⁾

Sucrose added to the culture medium increases the dry weight with increasing concentrations, but no significant differences in the fresh weight, stem elongation and flowering stage are found on the media with more than 2 per cent sucrose under long- and short-day conditions.

In the dark culture, the stem elongation and fresh weight are somewhat decreased with increasing sucrose concentrations, although the dry weight and flowering stages are increased. These results indicate that light affects the growth of plants not only by the production of carbohydrates, but also by other influences on some metabolic processes as suggested by Went.¹⁴⁾

For the successful culture of higher plants under "heterotrophic" conditions, some practical difficulties must be overcome: The quality and quantity of the nutrients which are essential to the normal development of the plant must be clarified. A suitable method of supplying nutrients must be contrived. And last, the abnormal elongation or etiolation which may alter the physiological activities, must be inhibited by some means.

One of the examples of success in culturing higher plants heterotrophically to maturity was given by Spoehr¹⁰⁾. He cultured albino maize by feeding with sucrose given to the cut ends of the leaves under diffuse light. The plants grown under this condition, free from etiolation, were sturdy and developed to pistillation. But the exclusion of light is preferable for "heterotrophic" culture, since the light may have other biochemical effects besides photosynthesis.

Gorham has also succeeded in culturing *Lemna* under absolute darkness.⁵⁾ In this case the plants were fed with mineral nutrients containing sucrose, organic nitrogen (e. g., amino acids) and other growth factors (e. g., yeast extract) through the fronds.

In the present work the wheat, Konosu No. 25, grew at least for 135 days after germination and developed to the flowering stage 4 (see Table I) on the mineral medium containing 10 per cent sucrose in absolute darkness. The plants showed the typical symptoms of etiolation. The elongated main axes were almost dead after a limited growth and further growth and development was succeeded by the

new tiller, which was brought about by adding the higher concentrations of sucrose. The most vigorous growth, however, was observed when some parts of shoots had been imbedded in agar medium and the nutrients were supplied through the leaves.

For the initiation of flower primordia and the development up to anther formation at least, light is not indispensable in the wheat plant, but the number of leaves formed on the axes before flowering—the number is directly related to the development⁸⁾—is influenced by light period. Before flowering, Konosu No. 25 develops about 5 leaves in the long day, 7 in the short day and 10 in darkness. The results are interesting as compared with those obtained in other plants by previous authors (Table VI).

Table VI. Number of leaves on flowering shoots

Materials	Photoperiodic conditions			Researchers
	Long day	Short day	Darkness	
Alaska pea	7	12	7	Leopold, A. C. ⁶⁾
<i>Raphanus sativus</i> L.	$8.7^{*1} \pm 1.3$	11 ± 1.0	8.2 ± 1.1	Tashima, Y. ¹¹⁾
<i>Baeria gracillis</i>	$4.8^{*1} \pm 0.15$	7.1 ± 0.23	6.2 ± 0.16	Takimoto, A. ^{*2}
Wheat (Konosu No. 25)	5 ^{*1}	7	10	

*1 Continuous light

*2 Report presented in the 20th General Meeting of the Botanical Society of Japan at Hiroshima, 1955.

With regard to the effects of light on flowering, three cases were found.

- 1) Short day treatment retards flower initiation as compared with long-day and dark treatments: Pea and radish.
- 2) Increasing duration of light accelerates flower initiation: wheat.
- 3) Long-day treatment accelerates and short-day treatment retards the initiation of flower primordium as compared with dark treatment: *Baeria*.

In a recent paper Sen and Leopold,⁹⁾ citing the works of Tashima¹¹⁾ and others on the dark cultures of radish and other plants, have recognized the physiological significance of sugar added to the medium in flower initiation. As shown in the present work (Tables II, III, IV), under short days and especially in dark culture the amount of sugar added to the medium has a very significant influence not only upon the survival of plants but also upon the flowering in wheat. The flowering percentage and flowering stages increase with increasing sugar concentrations. Under continuous illumination, however, sugar has, if any, a very slight influence on flowering. The lengthening of light period seems to compensate for the absence of sugar in the culture medium. This may be interpreted from the nutritional standpoint.

But in all plant in Table VI, with exception of wheat, flower initiation occurs earlier in dark culture than in short-day condition, suggesting that short days retard flower initiation. This indicates that the alternation of light and darkness is not only nutritionally but also morphogenetically of a decisive importance in flower initiation.

In contrast to the above plants, wheat initiates ear primordia earlier* in short days than in total darkness, suggesting that the nutritional factor plays a more dominant role in the initiation of flowers in the wheat than in the other plants such as pea, radish and *Baeria*.

Summary

1) The spring wheat, Konosu No. 25, was cultured on media containing White's mineral nutrients and sucrose of various concentrations under three photoperiodic conditions: continuous illumination, short days and total darkness.

2) The effects of sucrose concentrations on the growth and development of the wheat plant were investigated. For the normal development of the plants, more than 4 per cent sucrose must be added in darkness, 2 per cent in short days and no sucrose in long days. On dry matter production, effects of sucrose were appreciable under all light conditions.

3) In darkness the wheat plants could sustain their growth at least for 135 days and initiate flowers on the media containing more than 4 per cent sucrose.

4) The number of leaves formed on the axes before flower initiation was 5 in long days, 7 in short days and 10 in darkness.

I wish to express my deep gratitude to Prof. S. Imamura, Laboratory of Applied Botany in Kyoto University, and Assist. Prof. Y. Tashima of Kagoshima University for their helpful suggestion and criticism through the investigation.

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* In the wheat the main axis dies almost entirely in the dark and ear formation occurs on tillers. It is doubtful, therefore, whether the leaf number of wheat, which includes the leaves produced on tiller and main axis before flowering, can be directly compared with that of other plants in the Table.

The Effect of the Extract of Immature Bean Seeds on the Growth of Coleoptile and Leaf of Rice Plant

by Yutaka MURAKAMI*

村上 浩*: イネの子葉鞘と葉の生長に及ぼす未熟な菜豆の抽出物の影響

Received September 28, 1957

The hormone relationships in the growth of cereal leaves are less understood than those in the coleoptile growth. In the previous papers^{1,2)}, it was demonstrated that the sucrose-induced growth in length of the leaf sheath sections isolated from young cereal leaves was greatly inhibited by auxin such as indoleacetic acid (IAA) but stimulated by gibberellin. This IAA-inhibition was tentatively interpreted in terms of the so-called two-factor scheme proposed by Went³⁾. If this scheme is valid, then it will be expected that the growth of the basal regions of green leaves should not be affected by auxin. On the other hand, various growth substances other than IAA have now been found in several kinds of plant materials. Thus a principle or principles contained in the extract of immature bean seeds as reported by Mitchell, Skaggs, and Anderson⁴⁾ is an example. They observed that by the treatment with this extract the main axis of bush beans extended to result in the formation of very long internodes as in climbing beans. The writer found that similar responses were also observed if gibberellin was applied to bush beans. Hence, it seemed interesting to examine whether or not the growth of the intact rice seedlings is modified by the application of the above extracts. Such a study might give a clue to the elucidation of the hormone relationships in the growth of cereal leaves.

Methods

The rice seed used in these experiments was a race called "Aichi-Asahi". Seeds were soaked for 20 minutes in a 0.1 % solution of "Uspulun". They were then washed thoroughly and allowed to germinate at about 28°C. When the emerging coleoptiles attained about 1 mm in length, the uniform seedlings were selected and used for experiments.

The extraction of immature bean seeds was carried out in a manner described by Mitchell et al⁴⁾. Approximately 30 g of immature bean seeds taken from market pods that varied from 10 to 15 cm in length were extracted with moist

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ether at room temperature for 20 hours. The ether extract was evaporated and the residue was dissolved in 0.5 ml of 0.01 N sodium carbonate for paper chromatographic studies.

The extract so obtained was spotted on the starting line of a sheet of Tôyô No. 50 filter paper (25 cm×35 cm), in 5 small spots about 2 cm apart (Fig. 1, A~C). The chromatogram was developed in the ascending manner in the solvent mixture of isopropyl alcohol/water/ammonia ($D=0.88$) (10:1:1) at about 25°C for 16 hours, by which time the solvent front travelled about 28 cm. A mixture of IAA, ethyl indoleacetate (EIA), and indoleacetonitrile (IAN) was chromatographed simultaneously. (Fig. 1, D). The paper was then dried and cut lengthwise into 4 strips. These will be referred to as strip A, strip B, etc. Strips A and B were again divided transversely into 14 zones at 2 cm intervals from the starting line. (see Fig. 1). Each chromatogram piece of strip A was placed in a wide-mouth bottle 3 cm in diameter and 8 cm in height. To each bottle 1 ml distilled water was added, and 10 rice seedlings were planted in it. All bottles were placed in a large Petri dish which was kept in the glasshouse at about 28°C. The plants were grown under normal daylight conditions and were supplied with 0.5 ml distilled water every 2 days. The length of coleoptile and that of the first and second leaf were measured after 2 days and 7 days, respectively. At that time each leaf had practically completed its growth.

Strip B was used for the *Avena* straight-growth

assay of growth substances. Each paper piece was immersed in 2 ml distilled water in a wide-mouth bottle, and twelve 3.1 mm sections obtained from 2 cm oat coleoptiles were floated on the test solution. The bottles were placed in a water-saturated atmosphere at 25°C. The lengths of coleoptiles were measured after incubation for 18 hours.

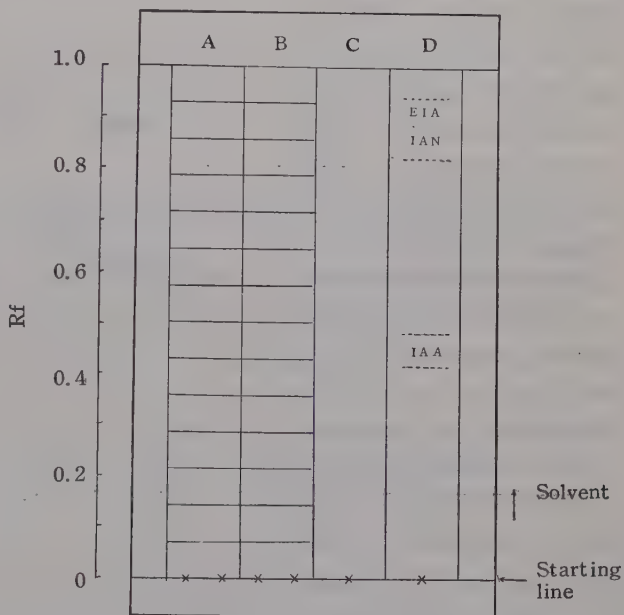


Fig. 1. Division of paper chromatogram of the ether extract of immature bean seeds.

The chromatogram was developed in isopropyl alcohol/water/ammonia (10:1:1). Strip A was used for the determination of activity in the growth of rice seedlings, strip B for *Avena* straight-growth assay, strip C for spraying with p-dimethylaminobenzaldehyde, strip D for determinations of standard spots of IAA, EIA, and IAN.

The positions on the paper chromatogram of known indole compounds were detected on paper strip D by spraying with p-dimethylaminobenzaldehyde (2 g in 20 ml HCl (S.G. 1.16)+80 ml ethyl alcohol). Under these conditions IAA had R_f 0.45, EIA R_f 0.9, and IAN R_f 0.85.

IAA was a commercial product. The method of Jackson⁵⁾ was used to prepare EIA. IAN was prepared from gramine as described by Henbest, Jones and Smith⁶⁾. Gibberellin A mixture was kindly provided by Prof. Y. Sumiki.

Results and Discussion

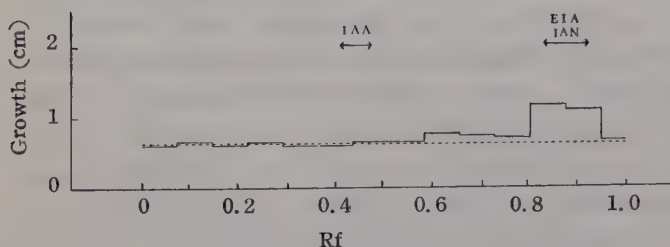


Fig. 2. Activity in the growth of intact rice coleoptile, shown as histogram, of pieces cut from paper strip A.

Measurements were made after 2 days. Broken line represents the growth of control.

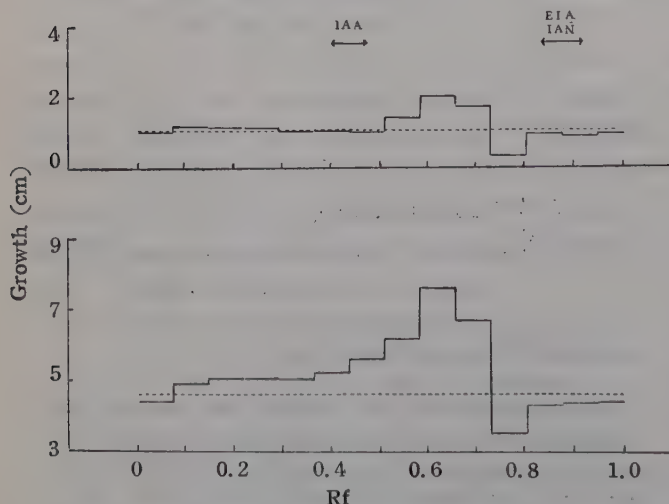


Fig. 3. Activities in the growth of foliage leaves of rice plants, shown as histograms, of pieces cut from paper strip A.

The upper histogram shows the growth of first leaf and the lower one shows that of second leaf. Measurements were made after 7 days. Broken lines represent the growth of controls.

The results of the experiments with paper strip A have been represented as histograms of the lengths of the coleoptile (Fig. 2), the first leaf (Fig. 3), and the second leaf (Fig. 3), plotted against R_f of the chromatogram. The horizontal broken lines in the figures represent the growth of controls.

In Fig. 2, where the effect of the extract on the growth of intact rice coleoptile was presented, only one growth-active zone was apparent at R_f 0.9. This growth promotion may be due to EIA or IAN since the active region lies close to the positions of standard EIA and IAN. Unlike the histogram pattern of Fig. 2, that of Fig. 3 representing the effects of the extract on the foliage-leaf growth showed one growth inhibiting zone of R_f 0.75 and one growth promoting zone

of Rf 0.65. In both figures, however, there was no peak of growth promotion corresponding to IAA. In paper strip C sprayed with p-dimethylaminobenzaldehyde, a pale purple colouration appeared at the region of Rf 0.9, and no coloured spots could be detected in other parts of the strip. Therefore, it may be considered probable that the concentration in the bean extract of IAA must be very low if it is present at all.

The *Avena* straight-growth assay is known to be more sensitive than chromogenic detection of IAA on the chromatogram. Hence, the paper strip B was examined for the presence of IAA by the method of *Avena* straight-growth assay. The results are shown in Fig. 4, where two clear zones with growth activity were apparent.

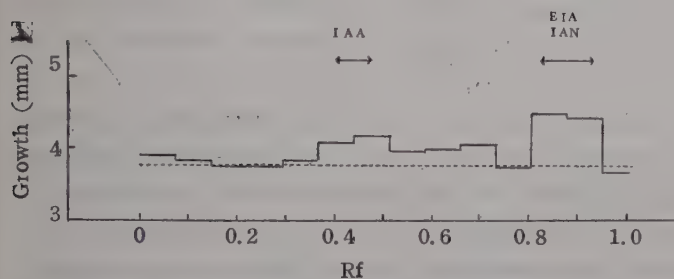


Fig. 4. Activity in *Avena* straight-growth assay, shown as histogram, of pieces cut from paper strip B. Initial length of section was 3.1 mm. Broken line represents the growth of control.

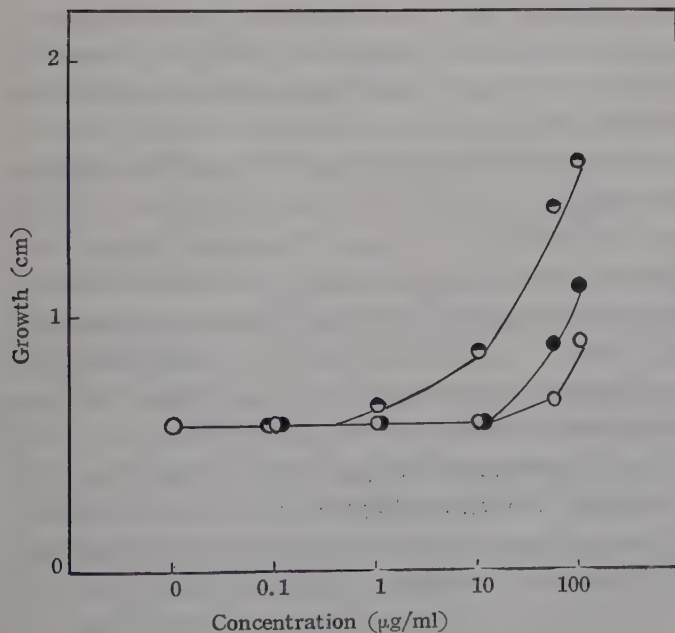


Fig. 5. Effects of various concentrations of IAA, EIA and IAN on the growth of intact rice coleoptile. (○) IAA, (◐) EIA, (●) IAN.

A zone of Rf 0.9 having growth-promoting activity for the *Avena* coleptile sections corresponded to the area marked by the stimulation of the growth of intact rice coleoptile. The other active zone of Rf 0.45, which corresponded to the position of the IAA marker spot, might be due to IAA.

IAA seemed to be less effective on the intact rice coleoptile, since its growth was not promoted by the eluate from the zone of Rf 0.45. Accordingly, the effect of IAA, EIA and IAN on the growth of intact rice coleoptile was compared. Ten seedlings were planted in 1 ml of each test solution in the bottles, and the length of coleoptile was measured after 2 days. Results of the typical experiment are represented graphically in Fig. 5. The data show that EIA was the most

active compound in promoting the intact coleoptile elongation, and that it was the only compound tested having activity at low concentrations of 1-10 $\mu\text{g/ml}$. Also, IAN was active at concentrations above 10-50 $\mu\text{g/ml}$. However, IAA was inactive at concentrations below 50 $\mu\text{g/ml}$. These facts suggest that free IAA is not always favourable for the growth of the intact rice coleoptile.

If IAN was present at concentrations above 50 $\mu\text{g/ml}$ on the region of Rf 0.9, then one would expect to obtain an intense purple spot with p-dimethylaminobenzaldehyde. As described above, the intensity of the colour developed with this reagent on the region of Rf 0.9 was too weak to account for the biological activity. Therefore, the compound detected on the chromatogram responsible for promoting growth of rice coleoptile may be EIA rather than IAN. For the identification of this compound a much larger scale experiment would be needed, and it will be the subject of future research.

As previously stated, the histogram pattern of foliage leaves differed from that of coleoptiles. Namely, in the former no activity could be detected on the area corresponding to EIA, and growth promotion was found at the zone with Rf 0.65 instead. A zone just above the growth-promoting zone showed inhibition of the growth of leaves. It appears that the substance in this zone might be identical with the inhibitor- β of Bennet-Clark and Kefford⁷⁾. The failure of the colour reaction with p-dimethylaminobenzaldehyde on these regions of strip C suggests that indole compounds were not involved in the growth activity of the leaf.

The active principles were separated by large scale paper chromatography. From a number of chromatograms developed on a large sheet of paper, portion of the strip having growth-promoting activity was excised and eluted separately with boiling 70 % ethyl alcohol. The eluate was concentrated and was applied in form of a small drop to the unfolding leaf of young bush beans. Only that eluate which promoted the growth of rice foliage leaves was able to affect the growth of bush beans, which grew like pole types by applying this eluate. The other eluates were almost inactive. Therefore, it seems likely that the effect of the extract observed by Mitchell et al. may be attributed to a factor located in the zone of Rf 0.65 with the solvent system used. Rice seedlings treated with this eluate grew taller and their appearance was similar to that of gibberellin-treated plants. Hence, for the sake of comparison, the Rf value of gibberellin A was measured with the same solvent system as employed above. The location of gibberellin A was made by bioassay of each successive region of the chromatogram with rice seedlings as test plant. A typical result is shown in Fig. 6. It is interesting that Rf of gibberellin A, 0.6-0.7, coincides with that of the growth-promoting factor of the bean extract.

Recently, Radley⁸⁾ obtained evidence for the occurrence of substances resembling gibberellic acid in the extracts of young pea shoots. On paper chromatograms, using solvent mixture of chloroform/ethyl alcohol/water/formic acid (20:4:2:1),

an active zone was found to have the same Rf value as that of gibberellic acid. Very recently, Phinney, West, Ritzel and Neely⁹⁾ have also reported that in a variety of higher plants including beans substances are present which are indistinguishable from gibberellins in respect of their biological activity towards dwarf mutants of maize.

In auxin studies it is frequently presumed that IAA or related indole compounds are either the dominant hormone or the only naturally occurring growth promoter in plants. Thus IAA, EIA and IAN have now been isolated in crystalline form from different plants. Auxin such as IAA has, in fact, been shown to stimulate the growth of the sections of oat coleoptiles, and the

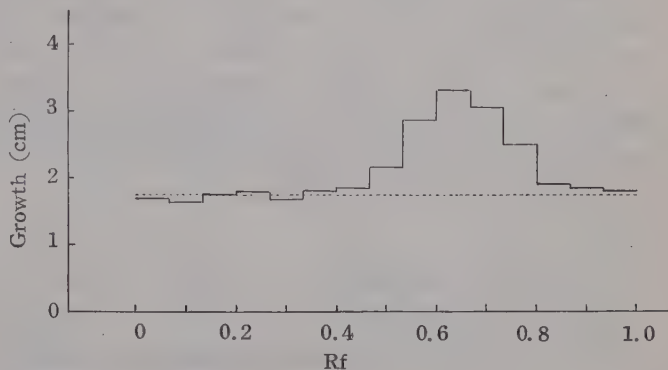


Fig. 6. Paper chromatography of gibberellin A (25 μ g) in ammoniacal isopropyl alcohol.

Biological assay of gibberellin A was made by measuring the length of second leaf of rice plant after 4 days. Broken line represents the length of control.

"*Avena* test" is widely used for the identification and quantitative estimation of natural plant growth hormones. However, auxin is almost inert for the growth of intact green plants. Although nothing is known at present about the chemical nature of the active principle of the bean extract, the experimental data seem to favour the view that indole compounds might not be involved in the growth promotion of foliage leaves of rice plants in the present work.

Summary

The effect of the ether extract of immature bean seeds on the growth of rice seedlings was studied. Attempts were made to separate active principles by paper chromatography.

The growth of the intact coleoptile was promoted by the eluate from the zone of Rf 0.9 in the solvent mixture of isopropyl alcohol/water/ammonia (10:1:1). EIA and IAN showed similar Rf to that of the coleoptile growth-promoting substance of the bean extract. Synthetic EIA was found to be 10 times more effective than IAA on the promotion of rice coleoptile growth.

On the other hand the growth of the intact foliage leaf was promoted only by the eluate from the zone of Rf 0.65 and inhibited by that of Rf 0.75. Gibberellin A showed similar Rf to that of the leaf growth-promoting substance of the bean extract.

The writer gratefully acknowledges the advice and helpful criticism which he

has received from Prof. T. Miwa and Dr. T. Hayashi during the experiments and in the preparation of this report.

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ミトリササゲ幼植物体の 形態分化に対する子葉の役割

(ミトリササゲにおける形態形成の研究, 第II報)*

堀 田 康 雄**

Yasuo HOTTA**: Roles of the Cotyledon in the Morphological
Differentiation of Bean Seedlings

(Morphogenetical Studies in *Vigna sesquipedalis*, II.)*

昭和32年7月27日受付

太田及びその協同者らによるミトリササゲの生長生理学的研究による諸知見との関連のもとに筆者は同植物において子葉が根, 胚軸, 上胚軸, 茎の生長点, 第1葉, 第2葉, 子葉腋芽などの組織, 器官の分化にどのような関係を有して居るかをしらべた。本報においては, 子葉を種々の発芽時期に種々な程度に切除して, 以後の幼植物体の形態的な生長, 分化に及ぼす影響をしらべ, 発芽期幼植物の形態分化に対する子葉の役割を見た。

材料及び方法

材料——*Vigna sesquipedalis* Wight, 培養法——主として Knop 液による試験管中, 27°C, 明処。

(堀田 1954, 川松 1957 参照)。試験管へ入れた時を第1日目とする。子葉及び上胚軸切断の場合, 切断面にラノリンを塗り水分発散を防いだ。

結 果

1) 子葉切除が上胚軸, 胚軸, 幼根の伸長に及ぼす影響。

1 日目 (第1図)。子葉の $\frac{1}{2}$ 量, $\frac{3}{4}$ 量, 全量を左右均等に, 又は片方だけから除去する (均等切除 (B, D), 不均等切除 (C, E))。上胚軸及び胚軸の伸長を第2図に示した。伸長の最もよいのは無切除個体であり (A-1, A-2), 切除量が多くなるにつれ伸長は低下し, 全量切除では最も悪い

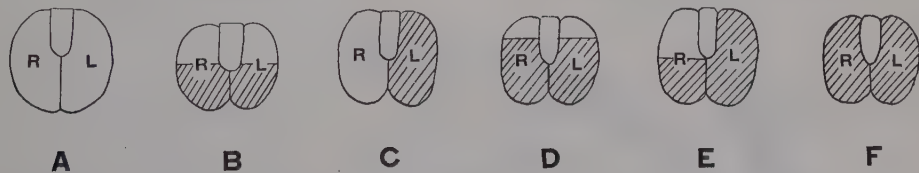


Fig. 1. Diagrams showing the modes of excision. Hatched areas, the excised parts of the cotyledon.

- A: No excision, viz., normal.
- B: $\frac{1}{2}$ equal excision. Excision of the distal halves of both cotyledons.
- C: $\frac{1}{2}$ unequal excision. Excision of one cotyledon.
- D: equal excision. Excision of the distal parts of both cotyledons.
- E: unequal excision. Excision of main parts in one cotyledon and of the distal half in the other.
- F: Entire excision, viz., decotylation.
- R: Right-hand cotyledon.
- L: Left-hand cotyledon.

* 本研究の一部は文部省科学研究費 (総合研究, 課題番号 4074) を用いて行われた。

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(F-1, F-2)。同一量の切除では、均等切除の方が不均等切除よりも伸長がよい ($B > C$, $D > E$)。

以上の関係は幼根についても同様。

7日目以後の伸長は、上胚軸と胚軸とで様子がちがう(但し全量切除では両者共全く伸長しない。

-1, F-2)。即ち、上胚軸は、子葉切除様式と殆んど無関係に一樣な伸長を示す (A-1, B-1, C-1, D-1, E-1 の破線部)。然るに、胚軸では対照及び $1/2$ 切除の場合、長さは減少し (A-2, B-2, C-2 点線部)、唯 $3/4$ 切除の場合だけ僅かに伸長する (D-2, E-2 破線部)。

第3図は子葉全量を切除した場合の上胚軸と胚軸の伸長状態で初期切除ほど強い伸長阻害を示す。3日目以前の切除では上胚軸は殆んど伸長しない。4日目以後の切除では上胚軸の伸長は幾分影響を受けるが、胚軸の方は殆んど全く影響を受けない。

上胚軸の直径の測定結果は対照個体、切除個体とも伸長生長の場合と同じ様子であった。

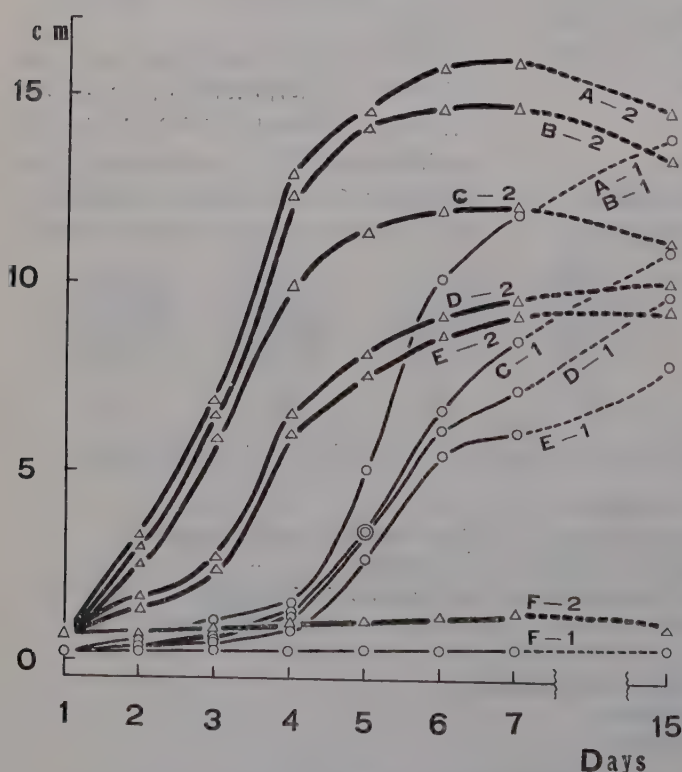


Fig. 2. Elongation of the epicotyl (1) and of the hypocotyl (2) after excision of the cotyledon in various modes. Symbols A, B, C, D, E and F as in Fig. 1.

2) 子葉切除が側根形成に及ぼす影響。

側根は、対照個体では3~4日目に外形的に認められ、6日目には50~60形本成される。2日目以前に子葉全量切除の個体は6日目にも側根は出ず、3日目切除では0~4本、4日目切除では4~8本、5日目切除では40~50本認められる。これは、明処培養でも暗処培養でも殆んど差がない。 $1/2$, $3/4$ の子葉切除では、各々その切除量に応じた変化がみられた。

3) 子葉切除が第1葉の発達に及ぼす影響。

対照個体の第1葉(対生)は、発芽と共に生長し展開し、生体重量、乾燥重量共に増加し、葉身の長さや厚さを増し、葉柄(葉枕)も伸長する。2~3日目に葉肉はさく状、海綿状の両組織に分化する(この時期に葉身の厚さの増加が最も急激に起る)。1日目に子葉を全量切除すると、幼葉の生長は著しい阻害を受ける。特に葉身の肥厚、さく状組織の分化共に起らず、葉肉細胞は多少丸味をおび、全体としてあつち葉肉となる(第4図)。2日目以後に子葉を全量切除した場合、第1葉の生長は切除時期が早期ほど強く阻害されるが、さく状組織だけは完全に分化する。

4) 子葉切除が茎の生長点の分化に及ぼす影響。

i) 対照個体。1日目: 第2葉以下の葉原基は全くみられない。2層の tunica と corpus 及び rib-meristem の区別は可能であるが、葉原基に分化する原細胞は明かでない。2日目: 生長点全体が各細胞体積の増大と細胞分裂により大きくなる。第2葉原基予定域には細胞分裂が tunica, corpus で盛んに始まる。3日目: 生長点は更に肥大し、第2葉原基が現れ、第3葉原基予定域で盛んな細胞分裂がみられる。各細胞の体積は2日目と変わらず、生長点の肥大は主として細胞増殖の結果である。4日目: 第2葉原基の生長、第3葉原基の出現、第4葉原基予定域の細胞分裂がみられる。5日目以後: 後続の葉原基が形成されてゆく。

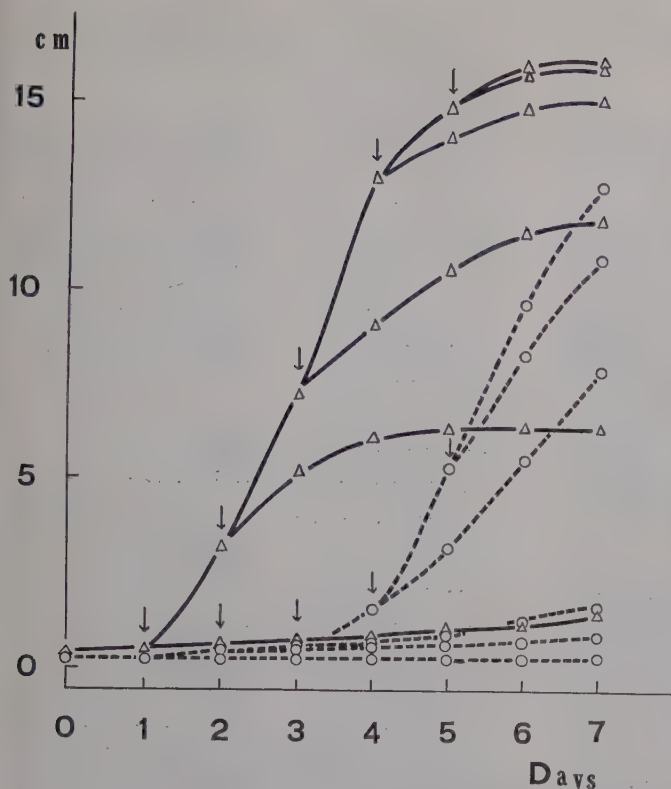


Fig. 3. Elongation of the epicotyl (brocken line) and of the hypocotyl (solid line) in the case of decotylization. Arrows show the time of decotylization.

8日目：生長点は葉原基の連続的分化によって非常に小さくなるが embryonic tissue の部域は1日目に比べ寧ろ逆に大きくなっている。細胞の大きさは tunica, corpus とともに1日目より小さくなる。

ii) 1日目に子葉全量切除の個体。
2日目：対照の1日目と大体同じ。幾分生長点が肥大する場合もあるが、第2葉原基予定域には細胞分裂の兆候は全くみられず、勿論葉原基は生じない。4日目：生長点の大きさ、細胞分裂の兆候については前日と同じ、corpusの細胞が体積を増し rib-meristemに当る部域が生長円錐体の内の方にまで拡がりその部域を増した。この部域の核の体積は幾分小さくなり、細胞体積は著しく増す。核は非常に小さくなった様にみえ

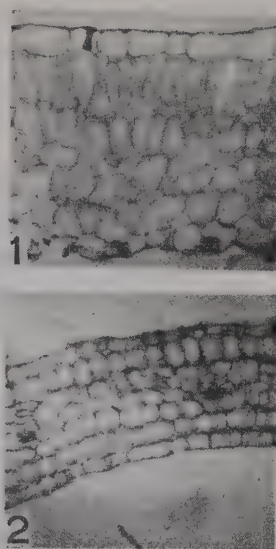


Fig. 4. Mesophyll of the plumule on the 6th day after germination. Differentiation of palisade and spongy tissue is seen in the control (1), and no differentiation of it in those seedlings whose cotyledon is removed entirely on the 1st day (2). ca. 100.



Fig. 5. Diameter and height of the shoot apex at the level of the uppermost leaf primordium in normal and decotylized seedlings.

る。6~8日目：生長点は大きくなり、葉原基ができかけ、原基附近で細胞分裂が少し起って居り、細胞体積は原基附近以外では増大する。9日目以後：できかけた葉原基は少しも発達せず、細胞は次第に液胞化し体積は増す。

生長点の底面（最も新しい葉原基の所で横切った面）の直径とその面より先端までの高さを測定した（第5図）。高さは、対照個体も1日目子葉全量切除個体も、全期間に亘って殆んど変化がない。直径の方は、切除個体では日と共に1方向的に増加する。対照個体では2~3日目まで急激に増し以後は減少する（減少過程に波がある：図中矢印。この波は、葉原基形成の準備期間の後、葉原基が出現した時直径が急に減ることの現れである）。8日目以後は対照、切除個体其直径は殆んど一定である。

2日目以後の種々な時期に子葉を全量切除した場合、相つづ葉原基の形成間隔（plastochrone）が長くなり、原基の生長も遅れる（同様な切除における上胚軸の生長と平行している）。

$1/2$, $3/4$ 量の子葉切除では、各々その切除量に応じた変化を示した。

5) 子葉切除が茎の生長点の細胞と核の大きさに及ぼす影響。*

対照個体。2日目まで細胞、核共体積は増すが、3日目から減る（核・細胞体積比は増大している）。rib-meristemの核・細胞体積比は余り変化しない。子葉全量切除個体。日と共に細胞体積は増すが、核体積は減る（核・細胞体積比は日と共に減少）。前項4)の切除個体4日目のrib-meristemの核、細胞の状態がこの最も典型的なものである。 $1/2$, $3/4$ 量切除では、各々その切除量に応じた変化がみられた。

6) 子葉の位置と第2葉の形成位置。

ミトリササゲの2枚の子葉は殆んどの場合若干上下にずれて正確には対生せず、且つ斜上方に曲って突出している。幼根を下にし、この突出方向を手前にして、左側を左子葉、右側を右子葉と呼ぶことにする（第1図参照）。

左右の子葉の上下関係（準位とよぶ）は次の如くである。左子葉が上：44%，右子葉が上：37%，左右子葉が同位：19%。

第2葉は種子の発芽後に生長点の分化により形成されるが、位置は第1葉に対して直角であるから左右どちらかの子葉の上方に当る。多くは右子葉側に第2葉を分化する傾きがある。左子葉を第1日目に全量切除すると、第2葉が特に右子葉側に形成される傾向はみられなくなる。右子葉を第1日目に全量切除したものでは、対照個体と同じ傾向がみられる。

7) 葉の状態が子葉腋芽の前葉の形態分化に及ぼす影響。（すべて鉢植材料）。

子葉腋芽は正常状態では殆んど形成されないが上胚軸切除では必ず子葉腋芽が分化する。3日目の切除では15日目に、5日目の切除では17~20日目に子葉腋芽が展開し、8日目の切際では20日目に認められる。形成された子葉腋芽に生ずる1対の前葉には種々な型がある（第6図）。

子葉の先端の方向と逆の側から出る前葉(A)**：3日目（まだ子葉の役割が大である頃）に上胚軸を切除すると、出て来るAの大半は托葉に類似した鱗片型であり（81.1%）、単小葉、2小葉、3小葉、4~5小葉型は少い（各々6.3, 1.5, 10.7, 0.4% 第6図A列）。5日目（子葉離脱前ではあるが既に子葉の役割が殆んど失われた頃***）に切除すると、鱗片型の出現は3日目切除にくらべ低下し（75.0%）、他には小葉型（25%）しかみられない（第6図B列）。8日目（子葉離脱後）に切除すると鱗片型の出現は更に低下し（54.9%）、他には単小葉型（3.9%）と3小葉型（41.2%）がみられる（第6図C列）。要するに、子葉への依存程度によって、前葉Aが托葉類似の鱗片型になるか尋常葉型になるかが左右される。

子葉の先端側から出る前葉(B)：Aと同様に種々の型があり、それらの出現の割合も早期に上胚軸が除かれる程、托葉類似の鱗片型の出現度が高い。

極めて低頻度で鱗片型であるAとBが合着して

* 詳細な測定数値、図等は別に報告する。

** 子葉腋芽の前葉では2枚が同準位に出現し、何れが第1葉であるか決定困難な場合が屢々ある。この場合は此の例数中に含めた。第1前葉が子葉の先端の向いている側に出た異常個体、その他の異常個体が少数みられたがこれは此の例数中に含めてない。

*** 子葉は特別な処理以外には、極めて正確に7日目に典型的な離層形成の後離脱する（堀田 1954）。











Type	Treatment			Treatment		
	A	B	C	A	B	C
	%	%	%	%	%	%
	48.0	42.3	31.4	81.1	75.0	54.9
	2.4	7.7	0			
	30.6	25.0	23.5			
	3.9	0	3.9	6.3	0	3.9
	2.4	0	0			
	1.5	0	0	1.5	0	0
	0.5	0	0	10.7	25.0	41.2
	0.5	0	0			
	9.7	25.0	41.2			
	0.5	0	0	0.4	0	0

Fig. 6. Types of prophylls on the cotyledonary axillary bud after removal of the epicotyl at various stages.

● : Main axis.

↑ : Cotyledon. Direction of the distal end of the cotyledon is shown by an arrow-head.

○ : Axis of axillary bud.

— : Prophyll of scale type like stipule.

— : Prophyll of single leaflet type.

— : Prophyll of two leaflets type.

— : Prophyll of three leaflets type, viz., normal foliage leaf.

A : Removal of the epicotyl on the 3rd day of germination.

B : Removal on the 5th day.

C : Removal on the 8th day.

1枚となった畸形もみられた。鱗片葉型と尋常葉型の間中型もまれにある(2.5%)。鱗片葉型前葉の葉脈は平行又は極めて簡単な走行様式である。前葉A, Bに次ぐ第3葉以下の葉は殆んど総て尋常葉型であり、且つ3小葉であった。

稀に自然状態で子葉腋芽が形成される特別な場合には、その前葉Aは単小葉、Bは3小葉の尋常葉型で鱗片葉型は全く生じない。

考 察

1. 子葉を種々な程度に、種々な発芽時期に切除した実験結果から、次の結論が導かれる：子葉を多量に且つ早期に切除する程幼植物体の生長、分化は抑制される。但し上胚軸、胚軸、幼根、側根、幼葉、茎の生長点等の各器官毎に受ける影響の度合は一律でない。これは子葉から供給される物質が幼植物体の各部分で発芽期に応じて特有な生理化学的变化を行い、それに基づいて形態分化の発現が現れるということで説明される。同様な結果が Kruyt (1954), Fries (1955) と宝月* によって得られている。

2. 子葉残量が同じでも、左右の子葉片から均等に切除したか不均等に切除したかによって、幼植物体の生長、分化の様式がちがう、特に上胚軸と胚軸において著しい。即ち、不均等切除が均等切除より切除効果大きい(伸長度の低下)。Kruyt は子葉を左右全量、片側全量、片側 $1/2$ 、 $1/4$ 量という様式で切除し、上胚軸、胚軸、幼根の伸長度、及び側根数をみたが、その切除様式ではみな不均等切除である故、均等切除との効果の比較は判らない。宝月のダイズの場合、 $1/4$ 量切除でやはり不均等切除の方が均等切除よりも幼植物の軸全体の伸長が若干悪いという(切除様式は全く同じ)。

不均等切除の方が伸長を悪くする原因として次の2つが考えられる：(1) 子葉をそのつけ根から切除する際、茎に傷を与える。(2) 子葉に先端と基部とで物質的又は生理的活性の勾配があり、不均等切除の場合は子葉基部を保有する事が少い故、例えば子葉残量が等しくても差が生ずる。(1)の可能性は、筆者の場合離層形成予定域が残るようには切除を行ったから問題ない。子葉内は維管束の走行と分布の方向性を除いてはごんぶんを含む

柔細胞が一樣に存在しているのみで基部と先端部に形態的差は認められない。唯植物ホルモンの濃度は基部が先端より高い事が確められた(堀田 1954)。ツルナシンゲンでは、子葉基部に発芽抑制物質が局在する(津山**)。故に不均等、均等切除で起される差は(2)の理由少くとも植物ホルモン量の差によるものであろう。

3. 子葉を1日目に切除した個体で、 $3/4$ 量切除以外は対照個体と同じく上胚軸は生長するが、胚軸の方は長さが減少する。然るに $3/4$ 量切除個体では、胚軸も同じく7日目以後伸長を続ける。これは、 $1/4$ の子葉が伸長生長速度を極めて低下させるので15日目までには減少過程が起らないのか、 $1/4$ 量残量が胚軸の本来の“減少”を消失させたのかであろうが、その生長曲線は前者の場合を暗示する。

4. 子葉切除は生長分化に段階的に影響を与える。即ち、発芽後4日目までに切除すると上胚軸特に胚軸の伸長阻害は著しく、それ以後の切除では少い(特に6日目では子葉の有無は幼植物の伸長に無関係)。この事は子葉内物質は発芽期前半に胚軸へ放出してしまう(太田 1954)、子葉内のチトクローム型が発芽期前半と後半で変る(Kumada 1953)、子葉内でごんぶん粒は発芽期後半に急激に減少する(川松 1957)という子葉内物質の変化に対応した現象と考えられる。

5. 幼根の伸長が子葉切除により阻害される事から側根形成も子葉切除の量及び時期に応じて阻害されることは当然である。両者の受ける影響の度合は大体平行している。Kruyt (1954), Fries (1953) も同じ結果を得ている。

6. 1対の第1葉は、既に完熟種子においてその構成細胞の大部分は分裂を完了して居り、発芽後の生長は、(i) 葉緑体形成及び生重、乾重の増加を伴う細胞の単なる伸長生長と、(ii) さく状組織の分化、の2つから成るといえる。重量及び細胞容積の増加(i)は明らかに子葉によって支配される上胚軸の生長に依存している(子葉切除実験による第1葉の重量及び細胞容積の変化の度合は、大体において同じ実験による上胚軸の伸長のそれと平行している)。

然し、その分化(細胞の極性をもった伸長)が起

* 宝月欣二氏の私信(1956)による。

** 津山尙氏の私信(1955)による。

るには、1日目までの間に子葉から供給された物質では充分でなく、少くとも2日目までの間に供給される量又は特定の物を必要とし、1日目と2日目の間に明瞭な段階がみられる(分化が形態学的に認められるのは2日目と3日目の間)。上胚軸自体は、1, 2, 3日目のいづれに子葉を切除しても、その伸長阻害度に殆んど差がないことから、上胚軸の生長状態が直接第1葉のさく状組織分化を規定しているとは思えない。

暗黒下の黄識化葉では、さく状組織の分化が起らないことが古くから知られて居り(坂村 1951)、暗黒又は高温度下でツルナシインゲンの第1葉の葉肉分化は強く抑えられている(Takeuchi 1956)。ミトリササゲの場合、暗黒下の対照個体ではやはりその分化は極めて貧弱である。子葉切除では、明処、暗処いづれでも第1葉のさく状組織分化はなく、葉緑体形成とさく状組織分化との間に直接の関連はないようである。

7. ミトリササゲの完熟種子の茎の生長点は、唯生長円錐体をなしているだけで、第2葉以下の葉原基は全く分化していない。発芽後、日を追って第2葉以下順次新しく分化してゆく。それ故、第1葉の展開的生長に比べて、生長点の分化(専ら第2葉以下の原基の分化)は発芽後の植物体全体の状態に強く左右される。子葉の量は生長点分化に強く影響し、特に子葉の有無は決定的で光は先づ無関係といえる(明処・暗処の両培養共生長点分化に関し大差なし)。この場合もやはり、子葉をより早期に、より多量に切除する程生長点の分化はより強い阻害を受ける。対照個体では2日目に第2葉原基が分化を始めるが、1日目に子葉全量切除個体では6~8日目に第2葉原基が出来かかるが結局それは発達せず終る。つまり0~1日目(種子を24時間27°Cの水に浸している間)に子葉から供給される物と生長点・茎等が元来もっていた物とだけでは生長点の分化、特に葉原基予定域での細胞分裂を正常に起し得ず、1日目以後子葉から供給される物が加わって始めて生長点の分化が起るといえよう。一方当然の事ながら生長点の分化は上胚軸の生長状態と密接な関係のある事が判った。生長点の大きさは葉原基を側方に形成する事と関連して、横巾(直径)の変化だけが問題であり、高さは葉原基形成の有無と殆んど無関係

である(第6図)のは興味ある事である。

8. 左右子葉が完全に対生でない事は胚形成に関する問題であり、ここでは立入った考察は省略する。

第2葉の形成時期や度合と子葉量の関係については既に論じたが、その形成位置(葉序の関係)と子葉の位置との間に注目すべき傾向が見出された。これに関し更に追求中であるが、左子葉切除が第2葉の位置を変える事は子葉が第2葉の位置決定に何か役割をしていると考えられる。左右の子葉は、形態的に(特に通導組織に関して)認め得べき差はない。左右子葉で生理的差があるのか(重量については差がある)、又は一对の第1葉の状態(特にその1対の重なり方*)が影響するが、今のところ決定的な論断を下し得ない。

9. 子葉腋芽の前葉は子葉への依存度が強い程鱗片葉型化する。鱗片葉型化は、葉原基の尋常葉への分化の抑制と考えられ、子葉への依存度の強い程分化抑制効果が大といえる。(i)子葉への依存度の強い程著しい。(ii)前葉Aに最も強く現われ、前葉Bでは弱く、第3葉には殆んど現われない。(iii)子葉離脱後も或時期まではその効果を有する事。などから考えて、この抑制効果は子葉に基因する何らかの一過性の作用物質によるものと思われる。ツルナシインゲンで2, 4-Dが葉の分化に対し抑制作用を起す部域は第2葉・第3葉である(Furuya & Osaki 1955)。ミトリササゲの子葉腋芽前芽はツルナシインゲンの場合の上述部域に当るもので、小葉数の減少(上述の鱗片葉型化)は子葉内の植物ホルモンによると考えられる。事実ミトリササゲの子葉には大量のオーキシンが存在している(Hotta & Ôta)。しかし、その抑制効果がこのオーキシンによるとすれば、前葉より上位部域には生長、分化の促進作用がみられてもよいが、それはない。故に子葉腋芽前葉の鱗片葉化の作用と考えられる子葉による抑制効果は、植物ホルモン以外の物質や条件をも含めて考慮しなければならない。

島村環、熊沢正夫、太田行人、原田市太郎の諸先生から御指導と御教示を得たことを記し感謝致します。

* 幼葉の重なり方との関係について別に報告する。

Summary

Elongation of the hypocotyl, epicotyl and radicle depends upon the amount of excised cotyledon; the greater it is excised, the more elongation is suppressed; in the case of the same amount of excision it comes out more prominently when equal amount is excised from the both sides of cotyledon than in that excised only from one side. Elongation is also more suppressed according an earlier excision. Formation of lateral roots is as well more inhibited in the case of a greater amount and an earlier time of excision. By entire excision on the 1st day the differentiation of palisade and spongy parenchymata of the 1st leaves does not occur, but by the same excision after the 2nd day it takes place. Development of the shoot apex is likewise suppressed by cotyledon excision.

Most of the 2nd leaves show a tendency to develop on the site above right side cotyledon; and by entire excision of either right or left cotyledon the phyllotactic position of them can be altered.

By removal of the epicotyl an axillary bud sprouts from the axil of each cotyledon. The stronger the cotyledonary activities were at the time of epicotyl removal, the more those axillary prophylls exhibit a scale nature like stipule; then it seems there may be some factors in the cotyledon which could suppress the development to foliage leaf of such prophylls.

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帽菌類の両和合性組合わせによる diploidisation で和合する核*

木 村 勘 二**

Katsuji KIMURA**: Nuclear Conjugation in Diploidisation by the Doubly
Compatible Diploid Mycelium in the Hymenomycetes.*

昭和 32 年 8 月 18 日受付

著者 (1954b) は前に、四極性のウシグソヒトヨ *Coprinus macrorrhizus* f. *microsporus* で、或る系統の一交配型、例えば AB の大菌叢の周縁に接して、自系統の核と他系統の核とを組合わせ、しかも両者とも AB 核と和合できる $ab+A'B'$ のような両和合性複相菌糸を植えて (以下 $AB \times (ab+A'B')$ のように記することにする) diploidisation を起させた場合、 AB 菌叢の周縁部に現われた複相菌糸の 2 核は $AB+ab$, $AB+A'B'$ のどちらであるかについて、多くの系統を用いて実験した。その結果は、組合わせた 2 系統の産地が互いに遠隔の場合は例外なく $AB+A'B'$ であったこと、しかし、この $AB+A'B'$ 菌糸が子実体を作り、その担子柄内で 2 核が融合、減数分裂して生じた次代の AB , $A'B'$ 菌糸と原菌糸の ab とを用いて、再び $AB \times (ab+A'B')$ の組合わせを行くと、今度は $AB+ab$ の複相菌糸が現われ、このような実験を続けると $A'B'$ と ab は 4 代頃まで交代して AB と和合する場合もあったことを報告した。そして上記の現象は組合わせた AB , ab , $A'B'$ 3 核の原形質の異同によるものであろうと推論したが、この問題について更に追究したところを以下に述べる。

材 料

本実験には前回同様、ウシグソヒトヨ *Coprinus macrorrhizus* Rea f. *microsporus* Hongo を用いたが、本菌の菌糸は野生子実体から分離した後、半年乃至 1 年を経過すると生活力が衰えて di-

ploidisation の実験には殆んど役立たなくなるから、前回の材料は全部用いず、新しく下記の 6 系統を供用した。

V, c, d 倉敷市にて著者採集

X, Y 新潟市にて松田一郎氏採集

e 大津市にて本郷次雄氏採集

これらの系統は互いに全く不和合性因子を異にし、異系統間の単孢子菌糸組合わせ培養では、すべて複相菌糸が生じた。これらを 2 系統ずつ組合わせて実験した場合、一方の不和合性因子を $AaBb$, 他方のそれを $A'a'B'b'$ であらわすことにする。

実験と結果

新しい系統を二つずつ組合わせて前回同様、 $AB \times (ab+A'B')$ のような型の両和合性複相菌糸による diploidisation の実験を行った。その各組合わせに生じた複相菌糸の 2 核を分析した結果は第 1 表のようである。なお、両和合性組合わせによる diploidisation の実験方法、diploidisation で現われた複相菌糸の 2 核の分析方法、培養基、培養温度等は、すべて既報 (木村, 1954 a, b) に準ずる。

今回も既報 (1954 b, 第 3 表) の結果と同様、大菌叢の核は他系統の核と和合して複相菌糸を作る場合が多かった。しかし、産地が互いに隔たった 2 系統を組合わせたものにも自系統の核と和合した場合が幾分見られ、また、接種した複相菌糸からの 2 核移行を証明するような結果も得られた

* 岡山大学理学部生物学教室 植物形態学業績 No. 60, 科学研究費 (課題番号 407097) による研究の一部。
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第1表 兩和合性組合わせによる diploidisation (1)

番号	組合わせ	出現複相菌糸の2核	番号	組合わせ	出現複相菌糸の2核
X(AaBb) と V (A'a'B'b') を供試			d(AaBb) と X(A'a'B'b') を供試		
1	AB×(ab+A'B')	AB+A'B' ○	12	AB×(ab+A'B')	AB+A'B' ○
2	ab×(AB+A'B')	ab+A'B' ○	13	ab×(AB+A'B')	ab+A'B' ○
X(AaBb) と e(A'a'B'b') を供試			14	ab×(AB+a'b')	AB+a'b' *
3	AB×(ab+A'B')	AB+A'B' ○	15	Ab×(aB+A'b')	Ab+A'b' ○
4	A'B'×(a'b'+AB)	A'B'+AB ○	16	aB×(Ab+a'b')	aB+Ab ×
5	a'b'×(A'B'+ab)	a'b'+ab ○	d(AaBb) と e(A'a'B'b') を供試		
c(AaBb) と X(A'a'B'b') を供試			17	AB×(ab+A'B')	AB+A'B' ○
6	AB×(ab+A'B')	AB+ab ×	18	ab×(AB+A'B')	ab+A'B' ○
7	ab×(AB+A'B')	ab+AB ×	19	ab×(AB+a'b')	ab+a'b' ○
8	Ab×(aB+a'b')	Ab+aB ×	20	Ab×(aB+A'b')	Ab+aB ×
c(AaBb) と e(A'a'B'b') を供試			21	aB×(Ab+a'b')	aB+Ab ×
9	AB×(ab+A'B')	ab+A'B' *	X(AaBb) と Y(A'a'B'b') を供試		
	”	AB+A'B' ○ }	22	AB×(ab+A'B')	AB+A'B' ○
10	Ab×(aB+A'b')	AB+A'b' ○	23	ab×(AB+A'B')	ab+A'B' ○
11	aB×(Ab+a'b')	aB+Ab ×	24	AB×(ab+A'B')	AB+A'B' ○
			25	ab×(AB+A'B')	AB+A'B' *
			c(AaBb) と d(A'a'B'b') を供試		
			26	AB×(ab+A'B')	AB+A'B' ○
			27	Ab×(aB+A'b')	Ab+A'b' ○

○ 印は大菌叢の核が他系統の核と和合した場合を意味する。

× 印は大菌叢の核が自系統の核と和合した場合を意味する。

* 印は移行2核が和合した場合を意味する。

No. 1~21 は産地が互いに遠く隔たった2系統の組合わせであり、No. 22~27 は比較的近い場合の組合わせである。No. 22~23 の ab と No. 24~25 の ab は互いに異なる胞子から由来したものである。

第2表 兩和合性組合わせによる diploidisation
で和合した核

供試の2距系離	実験回数	組合数	和合した核				
			○	×	○は又×	*	○は又*
遠	I	13	13	0	0	0	0
	II	21	12	7	0	1	1
近	I	7	4	2	1	0	0
	II	6	5	0	0	1	0
計		47	34	9	1	2	1

○, ×, * の各印の意味は第1表に準ずる。

が、これらはいずれも前回の結果では見られなかったものである。

いま、既報(木村, 1954b, 第3表)の第I回の結果と今度の第II回の結果とを合わせて要約する

と第2表のようになる。なお、同一の組合わせで同時に2回以上実験した場合は、まとめて一つの組合わせとして扱った。

次に前書きでも述べたように $AB \times (ab + A'B')$ で AB と $A'B'$ が和合した場合でも、この2核が融合、減数分裂して生じた次代の AB , $A'B'$ (以下 AB , $A'B'$ のように記することにする) と原菌糸の ab を用いて $AB \times (ab + A'B')$ の組合わせを行うと、今度は AB と ab が和合し、このことは核の原形質が AB と $A'B'$ とでは等しく、 AB と ab とでは違うことに起因するものであらうと前回に推論したが、この仮説を裏付ける目的で次の実験を行った。第1表の $AB \times (ab + A'B')$ で出てきた $AB + A'B'$ 菌糸, $ab \times (AB + A'B')$ で現われた $ab + A'B'$ 菌糸のそれぞれに生じた子実体から得られた新菌糸の AB , $A'B'$, AB' , $A'B$ 及び ab , $A'b'$, aB' , $A'b$ と原菌糸の AB

第3表 両和合性組合わせによる diploidisation (2)

番号	組 合 わ せ	出 現 複 相 菌 糸 の 2 核	番号	組 合 わ せ	出 現 複 相 菌 糸 の 2 核
X(AaBb) と V(A'a'B'b') を供試					
1	$\underline{AB} \times (ab + \underline{A'B'})$	$ab + \underline{A'B'}$ *	19	$\underline{A'B} \times (ab + \underline{AB'})$	$\underline{A'B} + ab$ ○
	”	$\underline{AB} + \underline{A'B'}$ × }	20	$\underline{ab} \times (\underline{AB} + \underline{A'B'})$	$\underline{ab} + \underline{AB}$ ○
2	$\underline{A'B'} \times (ab + \underline{AB})$	$\underline{A'B'} + \underline{AB}$ ×	21	$\underline{aB'} \times (\underline{AB} + \underline{A'b})$	$\underline{aB'} + \underline{AB}$ ○
3	$\underline{AB'} \times (ab + \underline{A'B})$	$ab + \underline{A'B}$ *	22	$\underline{A'b} \times (\underline{AB} + \underline{aB'})$	$\underline{A'b} + \underline{AB}$ ○
	”	$\underline{AB'} + ab$ ○ }	d(AaBb) と e(A'a'B'b') を供試		
4	$\underline{A'B} \times (ab + \underline{AB'})$	$\underline{A'B} + ab$ ○	23	$\underline{AB} \times (ab + \underline{A'B'})$	$\underline{AB} + ab$ ○
5	$\underline{ab} \times (\underline{AB} + \underline{A'B'})$	$\underline{ab} + \underline{AB}$ ○	24	$\underline{A'B'} \times (ab + \underline{AB})$	$\underline{A'B'} + ab$ ○
6	$\underline{A'B'} \times (\underline{AB} + \underline{ab})$	$\underline{A'B'} + \underline{AB}$ ○	25	$\underline{AB'} \times (ab + \underline{A'B})$	$\underline{AB'} + ab$ ○
7	$\underline{aB'} \times (\underline{AB} + \underline{A'b})$	$\underline{aB'} + \underline{AB}$ ○	26	$\underline{A'B} \times (ab + \underline{AB'})$	$\underline{A'B} + \underline{AB'}$ ×
8	$\underline{A'b} \times (\underline{AB} + \underline{aB'})$	$\underline{AB} + \underline{aB'}$ *	27	$\underline{ab} \times (\underline{AB} + \underline{A'B'})$	$\underline{ab} + \underline{AB'}$ ○
	”	$\underline{A'b} + \underline{aB'}$ × }	28	$\underline{A'B'} \times (\underline{AB} + \underline{ab})$	$\underline{A'B'} + \underline{AB}$ ○
c(AaBb) と X(A'a'B'b') を供試			29	$\underline{aB'} \times (\underline{AB} + \underline{A'b})$	$\underline{aB'} + \underline{A'b}$ ×
9	$\underline{AB} \times (ab + \underline{A'B'})$	$\underline{AB} + ab$ ○	30	$\underline{A'b} \times (\underline{AB} + \underline{aB'})$	$\underline{A'b} + \underline{AB}$ ○
10	$\underline{A'B'} \times (ab + \underline{AB})$	$\underline{A'B'} + ab$ ○	X(AaBb) と Y(A'a'B'b') を供試		
11	$\underline{AB'} \times (ab + \underline{A'B})$	$\underline{AB'} + ab$ ○	31	$\underline{AB} \times (ab + \underline{A'B'})$	$ab + \underline{A'B'}$ *
12	$\underline{A'B} \times (ab + \underline{AB'})$	$\underline{A'B} + ab$ ○		”	$\underline{AB} + \underline{A'B'}$ × }
13	$\underline{ab} \times (\underline{AB} + \underline{A'B'})$	$\underline{ab} + \underline{AB}$ ○	32	$\underline{A'B'} \times (ab + \underline{AB})$	$\underline{A'B'} + \underline{AB}$ ×
14	$\underline{A'B'} \times (\underline{AB} + \underline{ab})$	$\underline{A'B'} + \underline{AB}$ ○	33	$\underline{AB'} \times (ab + \underline{A'B})$	$ab + \underline{A'B}$ *
15	$\underline{aB'} \times (\underline{AB} + \underline{A'b})$	$\underline{aB'} + \underline{AB}$ ○		”	$ab + \underline{A'B}$ * }
16	$\underline{A'b} \times (\underline{AB} + \underline{aB'})$	$\underline{A'b} + \underline{AB}$ ○	34	$\underline{A'B} \times (ab + \underline{AB'})$	$\underline{A'B} + \underline{AB'}$ ×
d(AaBb) と X(A'a'B'b') を供試			35	$\underline{ab} \times (\underline{AB} + \underline{A'B'})$	$\underline{AB} + \underline{A'B'}$ *
17	$\underline{AB} \times (ab + \underline{A'B'})$	$\underline{AB} + ab$ ○	36	$\underline{A'B'} \times (\underline{AB} + \underline{ab})$	$\underline{A'B'} + \underline{AB}$ ○
18	$\underline{AB'} \times (ab + \underline{A'B})$	$\underline{AB'} + \underline{A'B}$ ×	37	$\underline{aB'} \times (\underline{AB} + \underline{A'b})$	$\underline{aB'} + \underline{AB}$ ○
			38	$\underline{A'b} \times (\underline{AB} + \underline{aB'})$	$\underline{A'B} + \underline{AB}$ ○

○印は次代の核と原菌糸の核と和合した場合を意味する。×印は次代の核同志が和合した場合を意味する。*印は移行2核が和合した場合を意味する。

又は *ab* を用いて第3表に示すような、いろいろな両和合性組合わせの実験を行った。もし、上述の仮説が真であるならば、これらの組合わせで現われる複相菌糸の2核は、単相大菌叢の核と、接種した複相菌糸の2核の中の下線をつけない原菌糸の核とである筈であるが、分析の結果は第3表に示す通りである。

第3表の結果は期待通りのものが多かったが、例外も若干現われた。また第1表同様、2核移行を示す結果も得られ、これらのいくつかについては表に見られるように、同じ組合わせで実験をくりかえしたが同じ結果は殆んど得られなかった。

考 察

著者 (1954 b) は前に2核の和合には交配型の外に核原形質の異同が関係すると推論したが、もし、ある系統の一つの子実体に生じたすべての胞子の核原形質が前に考えたように互いに全く相等的なものであるならば、第1表の中の×印を附したような結果は出ない筈であり、また2系統の核原形質が担子柄内の2核融合、減数分裂で全く平均されて、すべての胞子の核に均一に配分されるものであるならば、第3表の中の×印を附したのもも現われない筈である。それにも拘らず若干の

組合せに例外的の結果が出たことから、著者は更に次のように推論したい。

四極性帽菌類の核の和合には不和合性因子の A と B が関与し、Whitehouse (1949) によれば、両因子ともに約 100 の複対立因子があるものとされている。そして 2 核の不和合性因子がそれぞれ AB と ab 、又は AB と $A'B'$ のように A, B 両因子ともに相違する場合、2 核は和合するものとされているが、著者は 2 核の和合にはこれら主因子の A, B の外に、和合の強さをいろいろに左右する若干の変更因子が関係するものと仮定したい。そしてこれらの変更因子を C, D, E, F, \dots であらわした場合を正の因子、 c, d, e, f, \dots を負の因子とすると、和合できる 2 核の変更因子がそれぞれ $CDEF, \dots$ と $cdef, \dots$ のように正負の差が大きい場合は和合性が強く、 $CDEF, \dots$ と $Cdef, \dots$ 、 $CDEF, \dots$ と $CDef, \dots$ のように共通な因子が増すに従って和合性が弱まるものと考えたい。

本菌の染色体数は $n=4$ (木村・武丸, 1955) で、主因子の A と B は連鎖していない (木村, 1952)。それで A 因子の乗っている染色体を I, B 因子のそれを II, 他の 2 本の染色体を III, IV とすると、上述の変更因子の中には I, 又は II 染色体に座位して A 、又は B と連鎖したものもあるであろうし、或いは III, IV 染色体に座位するものもあるかも知れない。

いま、ある複相菌系の 2 核の交配型が AB と ab であり、おのおのの変更因子が $CDEF, \dots$ と $cdef, \dots$ であるとする。この菌系が子実体を作り、その担子柄の中で 2 核が融合し、引続き行われる減数分裂では 4 対の染色体は、それぞれ自由に分離する上に、交叉による因子の組換えも当然起るであろうから、1 個の子実体に生じた多数の胞子は AB, ab, Ab, aB の 4 交配型のどれかに属するとしても、それらの変更因子には程度の差はあっても相互の間に融合前には見られなかった共通性が存在する場合が多いものと思われる。上述の例のような複相菌系の 2 核の変更因子が互いに全く異なるということは自然界では恐らく稀であって、普通は多かれ少かれ既に共通の因子を持っているであろうから、従ってこのような場合は減数分裂してできる多数の胞子は変更因子に関して相互の共通性を一増しているものと考えられる。

上述のように同一の野生子実体に生じて変更因子に共通性のある AB, ab の 2 菌系、及びこれらとの共通性が比較的少ないと思われる他の野生子実体よりの $A'B'$ 菌系を用いて $AB \times (ab + A'B')$ の両和合性の組合せを行う時は、変更因子の差が大きい $A'B'$ 核の方が ab 核よりも強い和合性を AB 核に示して、これと対合するものといえる。しかし同一子実体に生じた胞子であっても、それらの変更因子の構成はいろいろであるから、相互間の共通性には程度の違いがあり、たまたま、この組合せに用いられた AB と ab の間の共通性が小さく、そのために AB と $A'B'$ の間のそれの方が大きいというような場合も比較的稀にはあるから、第 1 表で \times 印を附した結果も出てきたのであろう。

次に $AB \times (ab + A'B')$ で AB と $A'B'$ が和合した場合でも、この 2 核が融合、減数分裂して生じた次代の \underline{AB} , $\underline{A'B'}$ の変更因子は、前述のように共通性を増しているから、 $\underline{AB} \times (ab + \underline{A'B'})$ では、今度は ab の方が $\underline{A'B'}$ よりも \underline{AB} との変更因子の差が大きく、ために ab が選ばれて \underline{AB} と和合するものといえる。しかし、このような組合せにおいても \underline{AB} と $\underline{A'B'}$ の差の方が \underline{AB} と ab のそれよりも大きいという場合もあり得るから、第 3 表の \times 印の結果も出たものと思われる。

このように世代を重ねるに従い、組合わせた $AB, ab, A'B'$ の 3 核の変更因子は互いに共通性を増して行き、既報 (木村, 1954b) で述べたように、終には $ab, A'B'$ のどちらが AB と和合するかは機会的になつてしまうものであろう。

第 3 表の各組合せに用いた次代の菌系は前述のように第 1 表の $AB \times (ab + A'B')$ で和合した $AB + A'B'$, $ab \times (AB + A'B')$ で和合した $ab + A'B'$ が減数分裂して生じたものであるが、ただ、 c, X の 2 系統を組合わせた実験の場合には例外である。それは第 1 表の No. 6~7 で示すように $AB \times (ab + A'B')$, $ab \times (AB + A'B')$ の組合せでは、どちらも AB と ab が和合したから、第 3 表の No. 9~16 の組合せに用いた次代の菌系は、上記の両和合性組合せによる diploidisation を経て出てきたものではなく、原菌系の AB と $A'B'$ 、又は ab と $A'B'$ を交配して得られたものである。そして第 3 表の No. 9~16 の結果には \times 印のものは全く見られなかった。このことは原

菌糸 AB, ab 間の変異因子の差が $AB, A'B'$ 間、又は $ab, A'B'$ 間のそれよりも大きいという比較的稀な場合であり、従って $AB+A'B'$ 又は $ab+A'B'$ が減数分裂して生じた次代の菌糸の間では一層、変異因子の差が少くなるから、これらを用いたどの組合わせにおいても原菌糸の AB 又は ab が大菌叢の核と和合したものと考えたい。

Papazian (1950) は *Schizophyllum commune* (四極性) を用いての実験結果から、両和合性組合わせによる diploidisation で和合する核は、でたらめなものではなくて、ある組合わせでは接種した複相菌糸の 2 核の中、いつもきまった一方の核が単相大菌叢の核と和合し、このことは複対立因子になっている不和合性因子は皆、平等な和合性を示すものではなくて、何かの理由によってそれらの中のあるものが選ばれて和合するものであることを示唆すると述べているが、著者の仮説によればこのこともまた肯ける。

比較的狭い地域内の系統の間では自然の交配が行われて来たであろうから、産地が互いに近い 2 系統を供試する場合は、それらの間に既に変異因子についてかなりの共通性が存在することも想像され、従って第 1 表のような組合わせを行うと、同一系統の核同志が和合する場合は比較的に多いと考えられるが、第 2 表ではこの推察を裏付ける数字は見られなかった。しかし、もし産地が互いに近い 2 系統を組合わせた実験を数多く行うならば、期待するような結果が得られるかも知れない。第 1, 3 表ともに接種した複相菌糸の 2 核がどちらも単相大菌叢中を移行したと思われる結果が見られるが、これについては別報で論ずることにする。

終りに本研究について有益な助言を賜った岡山大学高橋隆平博士、並びに材料の蒐集に御協力下さった滋賀大学本郷次雄氏、新潟高校松田一郎氏に深く感謝する。

Summary

A study was made on the nuclear conjugation in diploidisation by the doubly compatible diploid mycelium, using *Coprinus macrorrhizus* f. *microsporus* (a tetrapolar fungus). A small diploid mycelium was inoculated at the periphery of a large haploid mycelium. One of the nuclei of the diplont derived from the same fruit-body with the haplont and the other from a different fruit-body. Both nuclei of the diplont were compatible with the nucleus of the haplont. Nuclear constitution of the diploid mycelium resulting from the doubly legitimate combination was analyzed. The result showed that, in many combinations, the nucleus of the large haploid mycelium conjugated with that from the different fruit-body, but, in some combinations, with the nucleus from the same fruit-body. The above result may be well explained on the assumption of modifiers which control the affinity of conjugation between two compatible nuclei.

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Chrysanthemum Yoshinaganthum における分化について*

田 中 隆 莊**

Ryuso TANAKA** On the Speciation in *Chrysanthemum Yoshinaganthum**

1957年8月27日受付

植物に於ける種の分化については、細胞遺伝学的研究がその原因又は過程を種々の場合に於いて明らかにし、ある場合には種内倍数性により、ある場合には核型の変化が関与しているなど多くの報告がある。そして種の分化の細胞遺伝学的特性は個々の種についてそれぞれ特徴があって甚だ複雑であるから、それぞれの場合が詳しく研究されねばならない。

筆者は四国の那賀川の流域に分布しているナカガワノギク (*Chrysanthemum Yoshinaganthum* Makino ex Kitamura) を細胞遺伝学的に精査した結果、本種の分化は他種との天然交雑が第一の原因でありこの自然雑種が稔性を有し且つ両親種と交配可能であるため順次異なる生態型を生じたと考えられることを確め得た。

材料及び方法

1952年から1955年までの4年間毎年ナカガワノギクの開花期の11月中旬から12月上旬に生育の場所を調査し、分布を調べると共に形態学的観察を行い、多くの場所からその場所を代表すると見做される株を多数採集し、これを実験園に移植して形態学的な形質を比較研究し、併せて染色体数の決定及び減数分裂に於ける染色体対合の状態を調べた。

体細胞染色体の観察は Tjio 及び Levan (1950) の方法の1部を改めた下斗米その他 (1956) の方法により行った。減数分裂の観察は田中 (1955) の方法により次の如くにした。(1) 若い蕾を醋酸アルコール (1:3) の液にて5時間固定後、(2) 酢酸鉄みようばんを媒染剤としてよく吸着させ、(3) スライドの上にて葯を取り出し酢酸カーミン

(1%) にて染色し (4) 軽く熱しておしつぶした。この方法によると染色体は濃赤灰色に仁は淡赤灰色に染められる。又細胞質は透明になるので染色体の形態がよく観察できる。

観 察

1. 地理的分布と種の分化

本種の分布を確めるために筆者是那賀川及びこれに近接する諸川の流域を詳しく調査した。調査した諸川及び調査地は次の如くである：

那賀川 (石立山、木頭、上木頭、中木頭、坂州木頭、沢谷、宮浜、日野谷、延野、鶯敷、加茂谷、大野、羽ノ浦)、勝浦川 (高鋒、横瀬、生比奈)、吉野川 (大杉、大歩危、小歩危、池田、半田)、桑野川 (長生、桑野)、日和佐川 (赤河内)、海部川 (川西)、物部川 (榎山)、仁淀川 (弘形、越知)、四万十川 (窪川、檮原、大正、昭和、十川、江川崎)、肱川 (野村、横林)。

この調査の結果、本種が那賀川の流域にのみ分布していることを確かめた。即ち、第1図に示した如く本種が那賀川上流の宮浜村谷口附近から下流の加茂谷村持井附近までの間にのみ分布し、その間約 30 km にわたり那賀川に沿い帯状に分布していることを確めた。

本種の分布区域内の多くの生育の場所に於いて、本種の形態及び生態を詳しく調べた結果本種が中流地区に於いて *シマカンギク* (*Ch. indicum* $2n=36$) と自然雑種を生じ、この地点を境として、種の分化をおこしていることを確めた。これを詳しく記せば次の如くである。

本種の標準型 (第2図 a)： 上流の宮浜村谷口附近から中流の鶯敷町田野附近までの間に主とし

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第1図 *Chrysanthemum Yoshinaganthum* の分布

● A 型 (標準型), ◐ B 型 (生態型), ◑ C 型 (生態型),
◎ 自然雑種 (*Ch. Yoshinaganthum* × *Ch. indicum*) ○ *Ch. indicum* (2n=36).
A: 谷口, B: 朴野, C: 川口, D: 延野, E: 田野, F: 北地, G: 永柱観音,
H: 大田井, I: 大井, J: 十八女, K: 深瀬, L: 持井

て分布す(第1図)。最も多数生じている場所の1つは延野村細口附近である。本型は主として川岸の岩磐(砂岩、礫岩、頁岩を主とする)の間隙に生育し、若干の茎を生ずる小さなクローンを形成す。本型の外部形態に関する観察結果は第1表及び第2図aに示した如くであり、本型の特徴が葉身が狭楔形、総苞外片が線形乃至長被針形で多毛である点にあることを確めた。記述の便宜上この標準型を以下に於いてはA型と呼ぶ。分類学上*Ch. Yoshinaganthum* Makino ex Kitamura (北村 1940) として記載されているものはこのA型と一致する。

自然雑種 (第2図d): 中流の鷺敷町北地附近

及び永柱観音附近に生ず(第1図)。この場所は川幅が狭く、兩岸は石灰岩地であり、自然雑種はA型の生じている川岸の岩磐とシマカンギクの生じている山麓傾斜地との間にある路傍の石垣及びその附近に生じている。この自然雑種は多形的であり、例えばある株は卵形葉を呈し兩種の中間形であり、ある株は楔形葉を呈し比較的ナカガワノギクに近似し、又ある株は広卵形葉を呈し比較的シマカンギクに近似している。この自然雑種の多型はF₁の分離により生じたもの、或は戻し交配に

第1表 *Chrysanthemum Yoshinaganthum* の3型に於ける外部形態の観察結果

	A 型	B 型	C 型
草 丈 (cm)	30~60	35~65	20~50
葉 の 形	狭卵形	広卵形又は狭卵形	狭卵形
1 葉に於ける鋸 歯 数	3~13	11~26	7~19
偽 托 葉	欠	多くは有	多くは欠
舌状花弁の色	白	淡黄又は白	白
舌状花弁の長さ (cm)	1.0~2.0	0.8~1.2	0.8~1.6
1 頭状花に於ける総苞片の数	35~55	24~35	29~41
総苞外片の形	線形又は長被針形にして多毛	広楔形又は楔形にして少毛	狭楔形又は線形にして多毛



第2図 *Chrysanthemum Yoshinaganthum* の3型及び自然雑種 (*Ch. Yoshinaganthum* × *Ch. indicum*) の葉. ×約1
a: A 型, b: B 型, c: C 型, d: 自然雑種

より生じたものなどを含むためと見做される。北村氏(1940)がワジギギク(*Ch. cuneifolium* Kitamura)として記載しているものはこの自然雑種の中のある株と一致する。同様の自然雑種が下流の深瀬附近に於いても少数ではあるが確かめられた。

中流以下の本種につき形態及び生態を詳しく調べた結果、次の如きB型及びC型の2生態型が分化していることを確めた。即ち、

B型(第2図b): 本型は中流の田野附近、下流の大田井附近及び深瀬附近に生ず(第1図)。その形態は第1表及び第2図bに示した如く葉身が広卵形、縁苞外片が広楔形である点に於いて特徴がある。本型は株によっては形態的に著しく異なる場合がある。本型は主として山麓の傾斜地に生育し、多くの場合大きなクローンを形成している。これらの諸事実から本型が前記の自然雑種の分離により形態的及び生態的に分化を来して生じ山麓の傾斜地に適応して固定したものであることが判る。

C型(第2図c): 本型は下流に広く分布し、主として大井、十八女、持井附近に生ず(第1図)。その形態は第1表及び第2図cに示した如く草丈が低く葉身が狭卵形である点に於いて特徴がある。第1表及び第2図cから判明する如く本型は多くの形質に於いて概してA型とB型との中間形を呈している。又本型が特有の生態を示すことを確めた。即ち、本型は川より約20m乃至200m離れた田畑の畦、路傍の石垣、傾斜地等に生育し匍匐状の茎を生じ、小さなクローンを形成してい

第2表 *Chrysanthemum Yoshinaganthum* の3型の減数分裂に於ける染色体の対合の変異と各対合の出現頻度

染色体の対合	A型	B型	C型
7IV + 4II	1		
5IV + 8II	1		
3IV + 12II	18		
2IV + 14II	69	5	5
1VI+1IV + 13II		2	
2IV + 13II + 2I		4	
1IV + 16II	42	23	22
1III + 16II + 1I		5	
18II	17	16	33
17II + 2I	2	5	

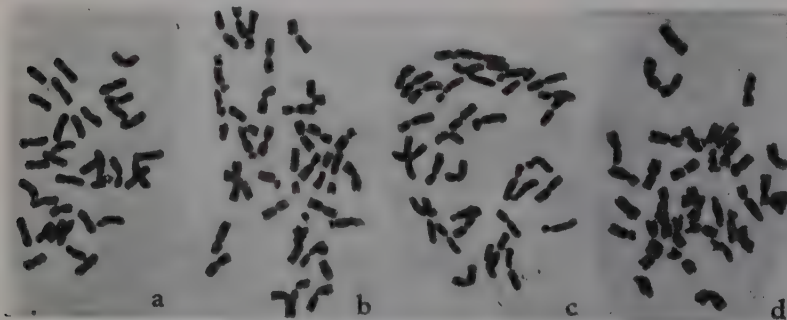
る。本型に於けるこの特異な形態及び生態が、A型及びB型と共に同一環境に於いて育成しても持続し、又子孫に遺伝することを確めた。このことは本型が特有の遺伝子を有していること及び新しい遺伝的平衡を確立していることを示している。この本型に於ける特異な形態及び生態は、雑種の分離と戻し交雑及び遺伝子の変化等のことが複雑に組み合わされて生じたものと見做されこの点は細胞遺伝学的にも確かめられた。

2. 染色体数と減数分裂に於ける染色体対合。

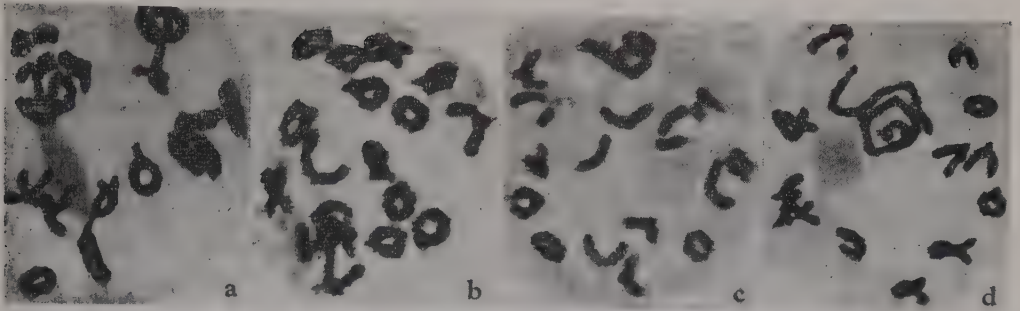
本種に於ける分化の原因の一端を知るために、A型、B型、C型及び自然雑種につき染色体数及び減数分裂に於ける染色体対合を研究した。その結果は第3図、第2表及び第4図に示す。

1. A型、 $2n=36$ (第3図a)、 $2IV+14II$ (第4図a)。採集地を異にする29株につき研究した結果、すべて $2n=36$ であり、減数分裂に於いて $2IV+14II$ が多く出現し稀に $7IV+4II$ 、 $5IV+8II$ が出現することを確めた。これらの事実から本型が染色体の相同性の高い四倍体で所謂同質四倍体に類似のものであることが判明した。

2. B型、 $2n=36$ (第3図b)、 $1IV+16II$ (第4図b)。本型は染色体



第3図 *Chrysanthemum Yoshinaganthum* の3型及び自然雑種(*Ch. Yoshinaganthum* × *Ch. indicum*) の根端細胞に於ける染色体。 ×約1000
a: A型, $2n=36$, b: B型, $2n=36$, c: C型, $2n=36$, d: 自然雑種 $2n=36$



第4図 *Chrysanthemum Yoshinaganthum* の3型及び自然雑種 (*Ch. Yoshinaganthum* × *Ch. indicum*) の減数第1分裂ディアキネシス期に於ける出現頻度の高い分裂像。×約 1100
a: A型 2IV+14II, b: B型 1IV+16II, c: C型 18II,
d: 自然雑種 1VI+1V+1III+11II.

数はA型同様、 $2n=36$ であるが、染色体対合に関してはA型とは相違している。即ち、1IV+16IIが多く出現し、しばしば一価、三価、六価染色体等が形成される。これらの事実は本型の染色体の組み合わせがA型のそれに較べて相違していることを示している。

3. C型、 $2n=36$ (第3図c)、18II (第4図c)。本型の染色体数は $2n=33$ であり前記A型及びB型と同じであるが、減数分裂に於いては18IIが多く出現し、この点に於いてA型及びB型とは相違している。このことは本型の染色体の組み合わせがA型及びB型のそれとは異なるものであることを示している。又対合が18II、1IV+16II、2IV+14IIの3種類のみ観察されたことは本型の染色体の組み合わせが安定していることを示している。

4. 自然雑種、 $2n=36$ (第3図d)、 $2n=34$ 、1VI+1V+1III+11II (第4図d)。自然雑種の染色体数は調べた16株が $2n=36$ であり、2株が $2n=34$ の異数体であることを確めた。この異数体は北地及び深瀬に於いて1株づつ見出されたものである。減数分裂に於いては1VI+1V+1III+11IIが観察された。かように六価及び五価染色体が出現することは転座が起きていることを示している。又対合は株によっては相違するものがあり、これについては目下研究中である。

本種の核型に関しては別報に於いて詳しく記すが、A型とC型との核型がほぼ一致していること、この2者に較べてB型の核型は二次狭窄を有する染色体が2本確められ、この点に於いて相違が生じていることが判ってきている。

論 議

近縁な2種の分布が交る区域には両種間の自然雑種が生ずることが多い。ナカガワノギクの場合もその一例である。しかしたまたまナカガワノギクの分布が1つの川の流域にのみ限られていたため、自然雑種がその中流域に生じたために、それより下流の流域にその自然雑種の子孫が生じ、本種の分化が起り且その分化の状況が比較的たやすく解明されたのである。

自然雑種の個々の株は自家不和合のために不稔であるが、他の株とは和合性を有して種子をつくるので、子孫を生じ染色体の分離及び組み合わせが起ったのである。又両親植物との戻し交雑も可能であって、特にナカガワノギクとの戻し交雑が天然に於いて起ったに相違ない。かようにして中流以下に於いては自然雑種の子孫に種々のものが生じたと考えられ、その中でA, B, Cの3型、特にB, Cの2型が現存するに到っているのである。

本種に見られたこの現象は Anderson (1949) が *Iris fulva*, *I. hexagona* var. *giganti-caerulea* の研究によって明らかにした Introgressive Hybridization と類似しているが、*Iris* の Introgression なる現象に於いては F_1 が不稔であり、戻し交雑のみが行われ従って他種の性質が一方に移入されるのであるが、本種の場合には戻し交雑も起きたのであろうが主因は F_1 の分離であって、そのために新たなる“型”が分離して生じたのである。この点が Anderson (1949) の *Iris* の場合とは本質的に違う点であり、又 Introgressive Hybridization と類似しているが異なる点である。

更に本研究に於いては細胞学的に分化の原因を究め得たのであって、分化の原因が染色体の組み合わせの相違にあることが証明されたことは従来の自然雑種に関する研究に於いては明かにされなかった新しい事実である。かように系統の異なる染色体が組み合わせの相違を生じていることは、筆者(1954)はワカサハマギク (*Ch. wakasaense*, $2n=36$) の分化に於ても確めたのであって、種の分

化に於いて染色体が組み合わせの相違を生ずることが1つの重要な原因であることが判ってきたのである。

終りに臨み、終始御懇篤な御指導と御鞭撻を賜った広島大学教授下斗米直昌先生に深甚なる感謝の意を表する。

Résumé

Chrysanthemum Yoshinaganthum is an endemic species, having a limited habit along the bank of the River Naka in the Province of Awa, Shikoku, Japan.

By means of cytological, systematical, and geotaxonomical studies, the following facts have been found: 1) In the valley on the upper-stream grows only the typical race (race A) of this species. 2) In the valley on the mid-stream grow the natural hybrids between *Ch. Yoshinaganthum* and *Ch. indicum* ($2n=36$). 3) In the valley on the down-stream grow newly developed two ecological races (race B and race C). 4) The three races have the number of chromosome $2n=36$. 5) The three races differ, with one another, in the conjugations of chromosomes at meiosis I. 6) The differentiation of the races B and C must have originated by the difference in the combination of chromosomes.

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投稿の注意

- 1) 投稿は会員に限りす。
- 2) 原稿は簡潔に書き、原則として刷上り 6 ページ (図表, 摘要, 文献を含む) 以内で, 他に印刷されていない内容であること。
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- 5) 表題及び著者勤務先は和欧文で書くこと。
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- 7) 文献引用の形式その他の記号は, 本誌最近号を参照のこと。

(例) Bot. Mag. Tokyo 69: (1956)

Journ. Fac. Sci. Univ. Tokyo III, 6 (1):
1 (1954)

- 8) 速報は緊急発表を要するものに限り, 刷上り, 1 ページ以内のものとし, 1 ページ 1500 円をそえて投稿のこと。
 - 9) 原稿の採否, 修正, 体裁及び登載の順序はすべて編集委員会の決定によります。特に編集委員会が認めた場合は, 制限ページ数を越えた分及びアート図版を著者の実費負担で載せることがあります。
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- 東京都本郷局区内
東京大学理学部植物学教室内
日本植物学会編集幹事
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特に欧文原稿について

- ① 原則として投稿前予めそれぞれの語を常用している外人 (例えば英語ならば英米人) に見せ, 少くとも文法, 文体上 (以下語学的と呼ぶ) の誤りのないことを期して頂きたい。
- ② 編集委員が必要を認め, 且つ投稿者の同意を得た場合には, 編集委員会から適当な外人に上記語学上の補正を求める場合がある。この場合は外人への謝礼の実費を申し受けます。

お知らせ

今迄論文が 6 ページを超えた場合, 超過した 1 ページにつき 1500 円を著者に負担していただきましたが, 来年 1 月号から 1 ページ 1200 円とすることになりました。御承知下さい。

日本植物学会75周年記念大会

75周年記念大会(第22回大会)は10月12日より15日までの4日間、東京大学教養学部において行われた。一般講演の他に、種々の記念行事が行われ、若干の変更があったが大体プログラム通りに終了した。

一般講演は4会場で分類、植物地理、細胞、遺伝、形態、生態、生理、生化学の各部にわかれて行われた(別掲の通り)。

外国からは中国科学院を代表し羅宗洛、鄭万鈞の両氏、アメリカ植物学会を代表し E. H. Walker 氏が出席され、13日、14日にわたり3氏の特別講演が行われた。記念式は総会にひきつづいて催され、まず小倉大会会長の挨拶に始まり羅宗洛、E. H. Walker 両氏の祝辞が述べられた。次に諸外国からのメッセージ、祝電(別掲)が、服部会長の翻訳で湯浅明氏によつて読みあげられた。ついで本会に50年以上会員として貢献された次の17氏(五十音順)に小倉大会会長より感謝状と記念品が贈呈された。

朝比奈泰彦、大賀一郎、影山藤作、草野俊助、黒田長礼、桑田義備、郡場 寛、小南 清、斎藤賢道、武田久吉、多湖実輝、田原正人、中野治房、野原茂六、服部広太郎、三宅騏一、保井コノ

その後、記念講演に入り、小倉 謙、草野俊助、篠達喜人の3氏による学会75年の歩みが顧みられ記念式は終了した。

評議員会 (10月11日午後5時、於学生会館別館8号室)

出席者 評議員21名(欠席4名)、会長、幹事長、幹事6名

服部会長の挨拶につづいて、原幹事長より本会事務に関する次の諸報告が行われた。1. 役員移動、2. 現在会員状況、3. 昭和31年度決算、4. 昭和32年度会計中間報告及び収支予定、5. 昭和33年度予算、6. 植物学雑誌刊行経過及び予定、7. 図書の交換、寄贈の状況、8. 所蔵外国雑誌目録の印刷(10月号添附)。また、植物学雑誌小倉記念号(昭和31年10.11月号、12月号)刊行に対する小倉謙氏の会長宛感謝状が読みあげられた。

つぎに同じく幹事長より植物学会75周年記念

大会の記念事業として 1. 外国代表者の招待、2. 本会会員50年以上の17名に対し感謝状、記念品の贈呈、3. 記念講演、4. 外国招待者の特別講演等を行う旨報告があった。

ついで、次の諸事項の協議及び決定が行われた。

1. Thunberg 記念碑除幕式代表派遣の件：本年11月11日長崎において行われる Thunberg 記念碑除幕式に代表を2名出席させる。

2. 文部省学術奨励審議会科学研究費等分科審議会委員候補者の推薦：二名連記投票の結果、和田文吾、三輪知雄、亙理俊次の3氏を推薦することに決定した。

3. 昭和33年度大会の件：次期大会は九州支部内において行うこととし、小島 均氏を大会会長に推すことに決定した。なお、小島 均氏よりは次期大会に関する予定として、会場は福岡、会期は10月22日～25日に行う旨の報告があった。

4. 昭和34年度大会地に関する件：昭和34年度大会を大阪大学生物学科10周年記念大会と合同で行うことの提案が芦田譲治評議員より大阪大学の希望として出され、審議の結果、次の条項を本会評議員会の希望として出し、大阪大学及び京都大学の協議を求めることとした。

A) 動物学、植物学の一般講演を混合して行うことは会期が長くなるため、両者の講演は平行して行う。

B) 開会式、懇親会、特別講演などは合同で行っても差支えない。

上の希望が受け入れられた場合は34年度大会を大阪で行うことにし、受け入れられぬ場合は近畿・東北両支部が相談して開催地を定める。

5. 名誉会員、特別会員、および外国通信会員推薦の件：前年度評議員会の申し合せにより、創立75周年記念事業の一つとして名誉、特別、外国通信会員の推薦を協議し、次の諸氏を会長推薦によつて総会の承認を求めることになった。

名誉会員：J. Bonner, E. Bünning, R. W. Chaney, H. St. John, W. Ruhland, K. V. Thimann, 羅 宗洛、朝比奈泰彦、大木麒一、草野俊助、桑田義備、郡場 寛、斎藤賢道、野原茂六、服部広太郎、三宅騏一、保井コノ

特別会員：生駒義博，小倉 謙，黒田長礼，
多湖実輝，田中長三郎，並河 功

外国通信会員： F. R. Fosberg, B. Lindquist,
郑万鈞, H. Ullrich.

総会（10月14日，午後1時，於東京大学教養学部
第19大教室）

服部会長の挨拶の後，会長司会のもとに次の諸
事項の報告及び承認が行われた。

（1）役員移動の報告（会長，評議員：3月号掲
載，幹事長，幹事，編集委員：4月号掲載）

（2）現在会員の状況報告（昭和32年9月30日
現在：1151名，うち名誉会員5名，特別会員26
名，外国通信会員4名，終身会員52名，通常会員
1064名）

（3）会員移動の報告（昭和31年7月1日～昭
和32年9月30日：入会132名，死亡5名，退会
17名，除名83名，差引増加27名）

（4）植物学雑誌刊行経過及び予定の報告

（5）図書の交換・寄贈の状況報告（交換：国外
受理78，国外発送76，国内受理37，国内発送33，
寄贈：国外受理15，国外発送2，国内受理36，国
内発送1，其の他発送3，予約講読312）

（ ）内は予定

年	昭和31年										
刊行月	7-8		9		10-11		12				
収載 論文数	8		7		24		9				
頁数	41		46		154		65				

年	昭和32年										
刊行月	1	2	3	4	5	6	7-8	9	10	11-12	
収載 論文数	5	5	5	7	8	7	8	5	(6)	(12)	
頁数	18	34	28	38	39	44	48	48	(40)	(80)	

（6）昭和31年度決算の報告（昭和31年1月～
昭和31年12月：2月号掲載）

（7）来年度大会に関する報告（前記評議員会の
項参照）

（8）名誉会員，特別会員，外国通信会員の承認
（会長の推薦により，評議員会で協議した諸氏（評
議員会の項参照）の承認を求めたところ満場一致
で承認された）

以上の諸事項の報告承認で総会を終った。

日本植物学会第75周年記念大会を祝し各国から次のような祝辞および祝電が寄せられました。

THE AUSTRALIAN ACADEMY OF SCIENCE
Box 6 GPO Canberra ACT

Dear Sir,

On behalf of the Australian Academy of Science I wish to offer sincere congratulations of the 75th anniversary celebrations.

Unfortunately it will not be possible for the Academy to be represented at your Meeting in October, but you may be assured of our good wishes.

Yours sincerely,

J. C. Eccles
President

DET KONGELIGE DANSKE
VIDENSKABERNES SELSKAB
Kantes Plands 5. København V

Dear Sir,

The Royal Danish Academy of Sciences and Letters has with great interest and with best thanks received the information that the Botanical Society of Japan, Tokyo, is about to celebrate the 75th anniversary of its foundation, and our Academy very much appreciates the kind invitation to be represented at the celebration.

We regret, however, to inform you that owing to the long distances and the very expensive travelling expenditures, our Academy will not be able to send a delegate to the Annual Meeting, which will take place in Tokyo from October 12 to 14.

Our Academy is thinking you heartily for the important relationship between your Society and scientific institutions in our country. It is with the warmest feelings that we add our hearty greetings to the many others which you will surely receive on this occasion, and we express our sincere wishes for a successful and glorious future for the Botanical Society of Japan.

Yours sincerely

Niels Bohr
President

Jakob Nielsen
Secretary

SUOMALAINEN ELÄIN-JA KASVITIEETEELLIEN SEURA VANAMO SOCIETAS
ZOOLOGICA BOTANICA FENNICA VANAMO

Helsinki, Snellmaninkatu 9-11—Suomi (Finlande)

Botanical Society of Japan,

The Finnish Zoological and Botanical Society Vanamo sends respectful congratulations to the Japanese Botanical Society on the occasion of the 75th Anniversary of its foundation.

Your publications tell of a flourishing cherry orchard of knowledge tended by skilful hands. May it flourish eternally beneath the Japanese sun.

The Finnish Zoological and Botanical Society Vanamo

Viljo Kujala
President

Tarvo Oksala
Secretary

A La Société Botanique du Japon
à Tokio

La Société Botanique de France
est heureuse d'exprimer

à la Société Botanique du Japon

ses plus chaleureuses félicitations à l'occasion de son 75^{eme} Anniversaire et elle est particulièrement flattée et reconnaissante d'avoir été invitée à prendre part aux Cérémonies Jubilaires.

Pleine d'admiration pour l'œuvre scientifique de la Savante Société Japonaise, Elle forme le vœu que l'avenir lui réserve une riche moisson d'importants travaux et de glorieux lauriers.

Le Président de la Société Botanique de France,
Mouré

Der Botanical Society of Japan,

Zur Feier des 75jährigen Bestehens der Botanical Society of Japan entbietet die Deutsche Gesellschaft der Schwester-Gesellschaft ihre tiefempfundenen Glückwünsche. Diese Glückwünsche sind umso herzlicher, als unsere beiden Gesellschaften in diesem Jahr auf das gleiche Alter zurückblicken können.

Als im Februar 1882 Jahre Gesellschaft unter der Initiative von R. Yatabe und einigen wenigen jungen Botanikern mit Tatkraft und Enthusiasmus gegründet wurde,

berand sich die Botanik in Japan noch in den Anfängen. Seit dieser Zeit hat die botanische Wissenschaft in Japan einen ungeahnten Aufschwung erlebt, und japanische Forscher haben auf allen Gebieten hervorragendes zur Vertiefung unserer Kenntnisse geleistet. Dass in den vergangenen Jahren ein derartiger Wandel stattgefunden hat, ist in erster Linie das bleibende Verdienst Ihrer Gesellschaft und der Aktivität Ihrer Mitglieder. Ihr allbekanntes „Botanical Magazine“ ist ein sprechender Beweis dieser Tätigkeit. Zu diesen Erfolgen möchten wir Sie am heutigen Tage ganz besonders beglückwünschen.

Wir schätzen uns glücklich, dass die Beziehungen zwischen den japanischen und deutschen Botanikern stets die allerbesten gewesen sind. Hervorgehoben sei der herzliche Empfangen A. Engler am 25. 7. 1913 in Ihrem Kreise fand.

Wir wünschen der der Botanical Society of Japan weiterhin glückliche und erfolgreiche Tätigkeit zum Segen unserer Scientia amabilis!

Der Vorstand der
Deutschen Botanischen Gesellschaft

Dr. Hans A. Uschdraweit

THE INDIAN BOTANICAL SOCIETY

Professor J. Venkateswarlu
Secretary

Department of Botany
Undhra University
Waltair, India

The Indian Botanical Society, its President, Office bearers and Members thank you very much for your letter of February 22, 1957. On their behalf and on my own behalf I wish to convey to you our very sincere and very hearty felicitations and greetings on the occasion of the 75th anniversary of your learned society. Our Society has followed with deep interest and appreciation the very good work and achievements of your Society in the field of Botanical Science and allied Sciences. We hope that in the years to come a greater communication and exchange of ideas will take place between our two Societies, the co-operation between the members of which will no doubt further the cause of Botanical Science and its achievements and benefit mankind in its manifold aspects.

Wishing you all success in the deliberations of the 75th anniversary session of your learned Society.

J. Venkateswarlu
Hon. Secretary

KONINKLIJKE NEDERLANDSE
BOTANISCHE VERENIGING

le secretaris

Dr. A. Quispel

Galileiplantsoen 113-Amsterdam-O.

The "Royal Botanical Society of the Netherlands" congratulates the "Botanical Society of Japan" on the occasion of the celebration of its 75th anniversary.

Unfortunately our countries are too far away off each other to send a delegate who could visit your anniversary meeting, meet his Japanese botanical colleagues and enjoy the famous Japanese flora of which so many beautiful species are cultivated in our botanical gardens. While the Japanese people is well-known for its love and interest in flowering plants, your society has promoted the scientific study of all different aspects of Japanese botany. We hope that this study may be further stimulated by your society for many years.

Yours sincerely

Dr. J. Lanjouw
President

Dr. A. Quispel
secretary

POLSKIE TOWARZYSTWO

BOTANICZNE

Zarząd Główny

Warszawa, ul. Rakowiecka 8

Dear Sir,

We are extremely indebted for your kind invitation of your Society for the 75th anniversary of the Botanical Society of Japan.

Unfortunately we are unable this time to send our delegate to your Annual Meeting. This autumn was the election of the new authorities and this has caused the most deplorable delay of our message to your Society.

We have always admired the leading role of the Botanical Society of Japan in the promoting and developing of the science of botany in your country. The Japanese contributions are undoubtedly ones of most important to the development of botany in the world.

In occasion of the 75th anniversary of the Botanical Society of Japan we are sending you the most sincere wishes for the continuous and fruitful development of your Society and botany in Japan.

Secretary of the Botanical
Society of Poland
Prof. Dr. Tadeusz Gorczyński

With best regards

President of the Botanical
Society of Poland
Prof. Dr. Henryk Teleżyński

SOCIEDADE BROTERIANA

Instituto Botanico
Dr. Júlio Henriques
Coimbra
Portugal

Monsieur le Président,

Depuis 1892 que les relations entre votre Société et la Sociedad Broteriana sont les plus cordiales. De notre part nous avons accompagné avec la plus profonde joie le développement de votre Société et nous avons été toujours heureux de constater le magnifique rôle qu'elle a joué dans le progrès de la Science Botanique. Nous désirions donc prendre personnellement part dans les fêtes commémoratives de votre 75ème anniversaire, pour vous présenter, au nom de la Sociedad Broteriana, nos plus vives félicitations et vous remercier tout ce que votre Société a fait pour le développement de la Botanique. Cependant, comme la Sociedad Broteriana ne peut pas envoyer un délégué aux commémorations, je viens, au moyen de cette lettre, féliciter votre Société et lui souhaiter un avenir assez plein de succès scientifiques.

Veuillez agréer, Monsieur le Président, l'assurance de ma considération la plus distinguée.

Le Président,
Prof. Dr. A. Fernandes

CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS INSTITUTO DE ACLIMACIÓN DE ALMERIA (España)

Dear Sir:

This is to acknowledge receipt of your kind letter of February 27, 1957 with the notice of the diamond jubilee of your leading society.

Would be very interesting for us to accompany you in your Meeting, but we are not sure to be able to send a delegate from this Institute; but we will send to you by the end of next September a message with our best wishes for your society and your great country.

Cordially yours,
Fdo. Guillermo Verdejo.

SCHWEIZERISCHE
BOTANISCHE GESELLSCHAFT
SOCIÉTÉ BOTANIQUE
SUISSE

Sehr geehrter Herr Professor,

Am 12. Oktober 1957 gedenken Sie in Tokio des 75-jährigen Jahrestages der Gründung der Botanischen Gesellschaft von Japan. In alle Welt sind Ihre Einladungen zur festlichen Feier ergangen, und Freunde aus aller Welt werden an diesem Tage sich mit Ihnen verbunden wissen.

Es ist der Schweizerischen Botanischen Gesellschaft ein ehrenvolles und freudiges Anliegen, sich ebenfalls zu diesen Freunden zählen und Ihnen zur Gedenkfeier die herzlichsten Glückwünsche entgegenbringen zu dürfen. Die gemeinsame Freude und Anstrengung im Dienste der botanischen Forschung verbindet und über die Meere hinweg und lässt uns freundschaftlich Anteil nehmen am schönen Gedeihen unserer hochgeachteten japanischen Schwestergesellschaft.

Für die Schweizerische
Botanische Gesellschaft

Der Sekretär	Der Präsident
A. Jarl	A. Rutishauser

BOTANICAL SOCIETY OF AMERICA, Incorporated

Office of the President

A Greeting from the President of the Botanical Society of America:

Two thousand Members of the Botanical Society of America join me in sending our warm greetings and congratulations on the occasion of this 75th Anniversary meeting of the Botanical Society of Japan.

We have long held your Society and its Members in high esteem. The "Botanical Magazine," published by your Society, goes to every part of the world. Although most of us, your fellow botanists in the West, lack the skill to read or understand your ancient and respected language, your important researches are generally published in one of the international languages. We deeply appreciate the concern you thus show for botanists of other nations, that we may know and grasp the significance of your researches. Through this act of international enlightenment you demonstrate your understanding of the highest scientific ideals. Let it be the great hope of all of us that in the not too distant future, men in political life in all countries will develop the respect for truth, and integrity in communication, that we in science now enjoy!

Members of your venerable Society have a distinguished record of scientific achievement. An outstanding example of this, in relatively recent years, is the "foolish seedling" disease of rice. Its study led, in turn, to the discovery of gibberellic acid, and its relation to growth processes. This contribution to a better comprehension of plant growth has, alone, stimulated many hundreds of your colleagues in the West to strive to extend and further elucidate your history-making discovery.

Scientific investigation is but one of the many pursuits of men in the field of botanical science. Among you, as among us, there are many teachers in colleges, universities, and other schools. It is important that we pass on our ever-growing knowledge of the plant world to coming generations of students. May we all look forward hopefully to the time when people everywhere will have the pleasure of knowing more about plants.

Perhaps this broadened aim should be one of the worthy objectives for the next 75 years, one in which we of a younger civilization might well emulate your example.

Please be assured of our friendship and respect, and know that we count it an honor to salute you on this historic occasion.

George S. Avery, Jr.

October, 1957

TELEGRAM

LA SOCIETE BOTANIQUE DE L'URSS COMMUNIQUE SES FELICITATIONS LES PLUS SINCERES A LA SOCIETE BOTANIQUE DU JAPON A L'OCCASION DE LA DATE DE 75 ANS DE SON ACTIVITE SCIENTIFIQUE DE GRAND MERITE. VOTRE SOCIETE A BEAUCOUP CONTRIBUEE AU DEVELOPPEMENT DE DIVERSES BRANCHES DE LA BOTANIQUE AINSI QU'AUX INVESTIGATIONS DE LA VEGETATION ET LES SUCCES DES BOTANISTES JAPONAIS SONT TRES HAUTE-VALUE EN NOTRE PAYS. NOUS SOUHAITONS A LA SOCIETE BOTANIQUE DU JAPON DE NOUVEAU SUCCES EN CONSOLIDATION DES BOTANISTES JAPONAIS ET EN TOUTE SON ACTIVITE AU NOM DU PROGRES SCIENTIFIQUE.

VICE-PRESIDENT B. SCHISCHKIN

歴代植物学会会長



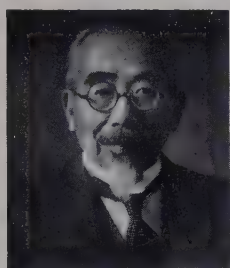
矢田部良吉
(1882-1890)



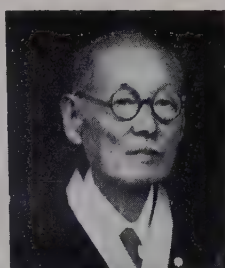
松村任三
(1891-1905, 1907, 1909-1922.)



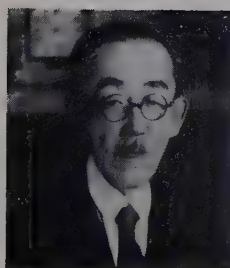
三好 学
(1906, 1908, 1923-1935)



宮部金吾
(1936)



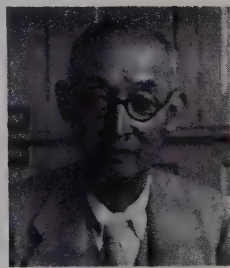
藤井健次郎
(1937)



柴田桂太
(1938-1939, 1942-1945)



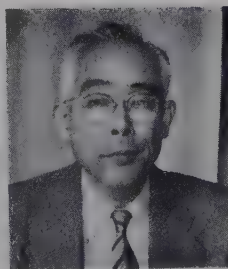
田原正人
(1940)



中井猛之進
(1941)



小倉 謙
(1946-1954)



服部静夫
(1955-)

日本植物学会 75 周年記念大会表彰者



朝比奈泰彦



大賀一郎



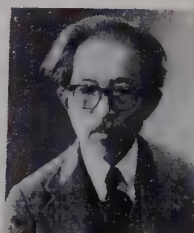
影山藤作



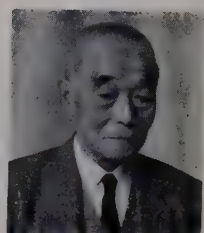
草野俊助



黒田長礼



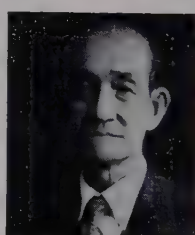
桑田義備



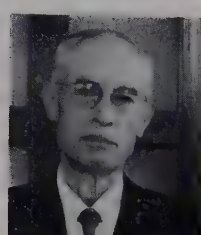
郡場 寛



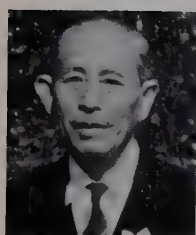
小南 清



斎藤賢道



武田久吉



多湖実輝



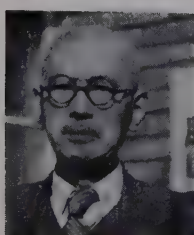
田原正人



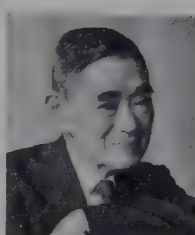
中野治房



野原茂六



服部広太郎



三宅駿一



保井コノ

朝比奈泰彦

明治 14 年 4 月東京に生まる。当年 76 才。第一高等学校を経て明治 38 年東京帝国大学医科大学薬学科卒業。大学院で研究を続け、明治 43 年薬学博士の学位を受く。大正元年東京帝国大学医科大学助教授、同 7 年同教授(医学部)。昭和 16 年定年退職、東京帝国大学名誉教授の称号を受く。昭和 5 年に帝国学士院会員、同 11 年ドイツ、ハレ市の Kaiserliche Deutsche Akademie der Naturforscher の会員、同 17 年ドイツ、ベルリンの Deutsche Chemische Gesellschaft の名誉会員に推選され、昭和 18 年には文化勲章を授けられた。昭和 25 年より資源科学研究所長、昭和 21 年薬理研究会理事、同 27 年には同研究所々長となり現在にいたる。専門は薬学および地衣類の化学成分、分類。明治 38 年以来 52 年間の植物学会会員。

大賀一郎

明治 16 年 4 月に生まる。当年 74 才。富山中学校、第一高等学校を経て明治 42 年東京帝国大学理科大学植物学科卒業。卒業と共に同副手。明治 44 年第八高等学校教授、大正 6 年南満洲鉄道教育研究所々員。大正 12 年から 15 年迄欧米諸国に留学。昭和 2 年古蓮実の研究により理学博士の学位を受く。昭和 7 年南満洲鉄道教育研究所退職。帰国後東京の自宅において研究に従事するかたわら関東学院大学において教鞭をとる。その間古蓮実の研究をはじめ、当麻マンダラ、布目文の研究および陸中中尊寺のミイラ、奈良正倉院資材調査等の調査研究も多い。専門は植物生理学、生態学。明治 39 年以来 51 年間の植物学会会員。

影山藤作

明治 9 年 1 月岡山県津山市に生まる。当年 81 才。明治 33 年東京帝国大学理科大学に学び、明治 44 年東京外国語学校専修科ドイツ語科学習。大正 5 年 9 月東京帝国大学助手(農学部)となる。昭和 24 年 4 月戸板女子短期大学講師、昭和 31 年 4 月より国士館短期大学講師となり現在にいたる。その間大正 5 年 5 月米国プリンストン大学で N. Harvey につき研究助手となり日本産ブリジナの研究を行う。大正 13 年 3 月ドイツ皇帝研究所長 R. Goldschmidt 教授につき研究助手等。外地における研究も多い。明治 40 年以前より 50 年以上の植物学会会員。

草野俊助

明治 7 年 3 月磐城国相馬郡八幡村に生まる。当年 83 才。福島県立安積中学校、第二高等中学校を経て明治 32 年 7 月東京帝国大学理科大学植物学科卒。同大学農科大学農科講師、明治 40 年同大学助教授を経て大正 14 年同大学教授(農学部)。昭和 6 年より東京文理科大学教授をも兼任。昭和 9 年定年退職、同年東京帝国大学名誉教授。其の間早稲田中学校、早稲田大学、日本女子大学、広島文理科大学、京都大学農学部講師を歴任。大正 2 年理学博士の学位を受け、昭和 8 年帝国学士院賞を受く。昭和 20 年 6 月帝国学士院会員。大正 4 年にはマーシャル、カロリン、マリアナ群島を調査し、大正 11 年 6 月より 13 年 12 月迄植物病理学研究のため米、伊、独に留学。専攻は植物病理学。明治 31 年以前から 59 年以上の植物学会会員。

黒田長礼

明治 22 年 11 月東京市赤坂区福吉町に生まる。当年 68 才。学習院高等科を経て大正 4 年東京帝国大学理科大学動物学科卒業。その後 5 年間同大学大学院に在学。大正 10 年より昭和 15 年まで宮内省主筆官。大正 13 年理学博士の学位を受く。昭和 14 年襲爵仰せつけられ貴族院議員就任。昭和 23 年農林省林野局林政部猟政調査室長、昭和 24 年林野庁指導部猟政調査課長、同年国立自然教育園評議員となり現在同会長。その間日本鳥学会創設に尽力し、日本生物地理学会会長、日本鳥学会会頭、魚の会会員、東京花協会会長、日本哺乳動物学会会長等となる。又大正 5 年台湾、同 6 年朝鮮の動物調査等を始め、昭和 3 年欧米視察、同 4 年にはジャワ、バリ、ロンボク調査等を行う。英、独、仏、和、ハンガリー等各国鳥学会名誉会員又は外国会員。専攻は鳥類学。明治 40 年より 50 年間の植物学会会員。

桑田義備

明治 15 年に生まる。当年 75 才。明治 41 年東京帝国大学理科大学植物学科卒。明治 44 年同大学副手。大正 6 年 9 月理学博士の学位を受け、同年東京帝国大学理科大学講師。大正 8 年英米両国に留学。帰朝後大正 11 年京都帝国大学教授(理学部)となり、昭和 17 年退職し翌年同大学名誉教授の称号を受く。その間昭和 9 年に海外に出

張す。昭和25年より国立遺伝学研究所客員。昭和28年より日本学士院会員として現在にいたる。専門は植物細胞学。明治40年より50年間の植物学会会員。

郡 場 寛

明治15年9月青森市に生まる。当年75才。青森県第一中学校(弘前), 第二高等学校を経て明治40年東京帝国大学理科大学植物学科卒業。大正元年同大学大学院卒と共に理学博士の学位を受く。大正2年東北帝国大学農科大学(札幌)講師, 同4年同教授となる。大正7年には米, 英, 伊, 仏, スイスへ留学。大正9年帰朝後直ちに京都帝国大学教授(理学部)となり, 昭和17年定年退職までの間京都植物園長, 京都帝国大学理学部長等をつとめた。内外各地への出張旅行も多く, 裏南洋(大正10年), ジャワ島(昭和4年), 欧南米諸国(昭和7~8年), 満州国, 内蒙古, 中華民国(昭和15年)を始め昭和17年には陸軍政務長官として昭長植物園長, 昭南博物館長となり昭和21年復員。昭和23年京都大学名誉教授, 昭和29年より弘前大学長として現在に至る。専攻は生理学, 生態学, 形態学。明治33年より57年間の植物学会会員。

小 南 清

明治16年4月東京に生まる。当年74才。第一高等学校を経て明治41年東京帝国大学理科大学植物学科卒業。同年より陸軍火薬研究所嘱託。明治43年東京帝国大学農科大学水産学科開設と共に授業補助嘱託となり水産細菌学, 水産病理学を講じ, 以来同大学実科講師, 本科講師, 助教授, 教授(農学部)を歴任す。其の間東大理学部, 東京高等師範学校, 日本女子大学校大学予科等の講師として水産学, あるいは細菌学を講ず。昭和16年定年退職後は長尾研究所理事, 主任研究員, 同25年所長となり今日に至る。この間昭和11年欧米留学。昭和29年欧米の国際微生物株保存機関連盟(IFCC)を歴訪し, パリの第八回国際植物学大会では菌学部会副会長として出席。専攻は細菌学, 菌学。明治39年以来51年間の植物学会会員。

斎 藤 賢 道

明治11年6月金沢市に生まる。当年79才。明治33年東京帝国大学理科大学植物学科を卒業。明治42年理学博士の学位を受く。同年農商務省

海外実業練習生として醸造業練習のためドイツに留学。明治44年満鉄中央試験所に入り同所長となる。昭和2年満鉄退社。同4年大阪工業大学教授。同8年大阪帝国大学教授となり同15年定年退職。大阪帝国大学名誉教授の称号を受く。この間欧米に留学。昭和15年から23年迄財団法人長尾研究所主任研究員。現在大阪醸造学会会長。専攻は発酵微生物学。明治31年以前から59年以上の植物学会会員。

多 湖 実 輝

明治16年12月東京市神田に生まる。当年74才。東京富士見小学校(武田久吉氏と同級), 城北中学校, 第七高等学校に学ぶ。其間薩隅, 日向の山野を跋涉。明治40年より第一高等学校で生物学に関する教務を嘱託, また長く明星学園で教鞭をとる。昭和9年第一高等学校助教授, 昭和23年同教授, 授昭和25年退職, 同年より日本歯科大学教授として現在に至る。専攻は海草分類学で数多くの新種の記載を行う。明治40年以前より50年以上の植物学会会員。

武 田 久 吉

明治16年8月東京に生まる。当年74才。明治43年渡英, Kew 植物園腊葉館等で研究, 其の間 Scottish Highland, Norfolk 沿岸植物, North Wales の山岳地帯調査を行う。大正元年 Imperial College of Science and Technology の advanced course を卒業後2年間同校の demonstrator となる。大正4年 Birmingham 大学の advanced course を卒業。再び Kew 植物園腊葉館等で研究を続け, 大正5年帰朝。大正5年より京都大学臨湖実験所, 中村植物研究所, 北大水産専門部に勤務。昭和3年より14年迄京都帝国大学農学部講師。昭和16年より終戦迄農林省高原調査会委員, 戦後は白百合学園講師, 総司令部天然資源局農学部顧問, 厚生省国立公園審議会委員などを勤め, 現在米国地質調査所技術顧問, 日本山岳会の創立につくし, 昭和23年より3年間同会長となる。理学博士。専攻は高等植物の分類学, 特に高山植物に関する研究。明治34年より56年間の植物学会会員。

田 原 正 人

明治17年7月山梨県甲府市に生まる。当年73才。長崎中学校, 第一高等学校を経て明治41年東京帝国大学理科大学植物学科を卒業。大正6

年理学博士の学位を受く。大正6年より10年迄第八高等学校教授、大正10年東北大学助教授に任ぜられ、同年より12年迄米、英、独に留学。大正12年東北大学教授(理学部)。昭和21年定年退職。昭和22年東北大学名誉教授の称号を受く。専攻は細胞学。明治40年以来50年間の植物学会会員で、昭和15年度日本植物学会会長として本学会につくす。

中野 治 房

明治16年4月千葉県葛飾郡湖北村に生まる。当年74才。東京府立第一中学校、第一高等学校を経て明治42年東京帝国大学理科大学植物学科卒業。大正5年理学博士の学位を受く。大正8年より13年迄第七高等学校教授、一時、鹿児島高等農林学校教授を兼任。大正13年東京帝国大学助教授、昭和9年同教授(理学部)、同18年定年退職。その間水産講習所、東京文科大学、京都帝国大学、名古屋帝国大学等の講師を歴任。昭和25年東邦女子理学専門学校校長、後に東邦大学理学部長となり現在にいたる。大正11年より米、英、独に留学、特に Harbølandt 教授の下で研究を積む。大正13年にはジャワおよびインドを視察。また長年にわたり史蹟名勝天然記念物調査委員としてつくした。専攻は植物生態学および生理学。明治39年より51年間の植物学会会員で、その間昭和3年より8年間植物学会幹事長として会につくした。

野 原 茂 六

明治3年8月三重県河芸郡箕田村に生まる。当年87才。三重県高等師範学校卒業後スタンホード大学で学び、明治40年バチエラー・オブ・アーツの学位を得て帰国。明治42年東京帝国大学農科大学助手、同講師を経て大正9年新設の水戸高等学校の教授となり、以来昭和8年迄熱心に学生の教育にあたり、退職後も東京巢鴨の自宅、終戦後は浜松市の自宅で研究を続く。水戸高校在職中は水戸博物学会会長として茨城県内の教員、有志等の自然研究の啓蒙を行い、水戸市郊外に百樹園(樹木園)の創設に協力する等茨城県における植物学の発展をはかった。昭和10年理学博士の学位を受く。専門は遺伝学。明治39年以来51年間の植物学会会員。

服 部 広 太 郎

明治8年5月東京市神田に生まる。当年82才。

神田錦華小学校、共立中学校(現開成中学)、第一高等中学校を経て明治32年東京帝国大学理科大学植物学科卒業。同34年より39年まで同理学部植物学教室助手。明治40年より昭和8年迄同講師として細菌学の講義を担当。大正4年理学博士の学位を受く。大正9年より2年間欧米留学。大正3年より8年迄東京御学問所御用係として博物学を御進講。大正3年より同11年迄学習院教授、大正11年より昭和17年迄徳川生物学研究所々長、大正14年より現在迄宮内省所属生物学研究所を主宰、陛下の生物学御研究の輔導に当る。専攻は細菌学、粘菌学、明治31年以前より59年間以上の植物学会会員。

三 宅 颯 一

明治9年11月兵庫県城崎町に生まる。当年81才。明治29年同志社理科学部大学部卒業。明治32年東京帝国大学理科大学植物学科選科修了。明治33年より米国コーネル大学に学び、同34年 M.A. 同35年 Ph.D. の学位を受く。明治35年より38年まで、ドイツ、ボン大学で研究。帰朝後同志社普通学校教師。明治39年4月理学博士の学位を受く。同年9月より東京帝国大学講師。同41年第一高等学校講師。明治44年東京帝国大学助教授、昭和7年教授(農学部)。昭和12年定年退職、其の間二度欧米巡遊、専攻は形態学、細胞学、遺伝学、明治31年以前から59年以上の植物学会会員。

保 井 コ ノ

明治13年2月香川県三本松町に生まる。当年77才。香川県師範学校を経て明治35年女子高等師範学校理科卒業。岐阜高等女学校および神田共立女学院で教鞭をとつた後、明治38年東京女高師研究科に入学。40年その課程を修了すると直ちに母校の助教授に就任、大正8年同教授、昭和24年お茶の水女子大学創立と共に教授に任ぜられ、27年3月定年退職、同大学名誉教授となる。その間東京帝国大学理科大学及び理学部で授業嘱託として大正6年以来長期にわたつて遺伝学を講じた。又大正3年 Chicago 大学および Harvard 大学で研究を行い、昭和3年には女子として初めての理学博士の学位を得た。Cytologia の刊行に協力し、現在その編集委員であり、昭和30年には紫授章を授けられた。専門は細胞学、細胞遺伝学。明治38年以来52年間の植物学会会員。

日本植物学会 75 年 史

小 倉 謙

東京植物学会の創立 明治 10 年東京大学が創立された時、理学部に生物学科が設けられ、動物学では米人 E. Morse 氏、植物学では米国に留学した矢田部良吉氏が教授となり、わが国で初めての近代生物学の講義と研究が行われるようになった。当時、職員も学生も少なかったが、翌 11 年 10 月に大学関係者を中心として東京生物学会が創立され、しばしば会合して生物学の普及発展に努めたが、事実上は余り振舞なかつた。そこで大久保三郎氏が肝入りとなって植物学だけの学会を設けようとし、伊藤圭介、賀来飛霞氏らに謀り、松村任三、宮部金吾、沢田駒次郎、岡田信利、大沼宏平、内山富次郎氏らと準備会を開き、さらに矢田部良吉教授と協議し、明治 15 年 2 月 25 日小石川植物園に集会して東京植物学会を創立し、会頭に矢田部良吉氏を推した。以上列記した人々がこの学会の創立者というべきで、この発会当日の参集者は 12 名であった。

植物学雑誌の創刊 学会創立当時はしばしば講演会などを催して互に知識の交換を謀ったが、植物学に関する専門雑誌を発刊する議がすすみ、明治 20 年 2 月 15 日付を以て植物学雑誌第 1 巻第 1 号が発行され、以来月刊雑誌として順調に発行された。しかしはじめの頃は発行所を東京植物学会編輯所、植物学雑誌編輯所としたことがあったが、これはただ発行所の名目を換えただけで、事実上学会発行と何等異なることがなかった。創刊当時の雑誌には外国教科書による解説、植物目録、旅行記のような啓蒙的、解説的、雑報的の記事が主で、独創的研究というようなものは稀であった。

矢田部声明 明治 22 年、植物学雑誌 3 巻に大久保三郎、牧野富太郎両氏がヤマトグサを新種として英文を以て記載し、これに *Thelygonum japonicum* n. sp. Okubo et Makino の名を与えた。これは日本における新種記載の最初のものとして記憶さるべきであるが、翌 23 年植物学雑誌 4 巻 44 号において、矢田部会頭は「泰西植物学者諸氏に告ぐ」と題する英文の論説を掲げ、“……従来日本の植物は一々欧米の学者に送って鑑定、命名せられたが、今や国内に標本や参考書が一応

整備されたので、以後欧米の学者にたよらずに吾吾の手を以てこれらのことしようと思う……”と述べ、白らシチュウゲ、ヒナザクラを新種として記載し、ついでキレンゲシウマを新属として記載した。この論説は分類学が独り立ちが出来るようになったことを内外に声明したものと見える。しかもこれを契機として他の方面に関する論文も植物学雑誌に載るようになり、この頃から漸くわが国における植物学が独立する機運に立ち至った。このようにして外国でもこの雑誌が Bot. Mag. Tokyo として引用せられるようになった。しかも明治 29 年におけるイチウ、ソテツの精虫発見により、そのことを誌した和文の記事が外国論文に引用されるようになった。

植物学学科の発達 植物の分類は遠く本草学時代から行われてきたとはいえ、真の意味の分類学は明治 20 年頃からわが国で行われるに至ったというべきであるが、明治 21 年松村任三氏が歐洲から帰朝してから帝国大学(東京大学は明治 19 年このように改称された)で形態学の発達に努めたので、明治 23 年頃からその方面の論文が植物学雑誌を飾るようになったが、その圧巻は何といっても明治 29 年のイチウ、ソテツの精虫発見であった。この頃、三好学氏が歐洲から帰朝して帝国大学教授となり、主として生理学の発達に努めたので明治 30 年頃からその方面の論文も見えるようになった。この頃植物学会でフローラに関する懸賞論文を募集したことがあったが、審査の結果明治 33 年 4 月 1 日長野菊次郎、川上滝弥、梅村甚太郎、岡田毅三郎の 4 氏が受賞した。

このようにして分類学、形態学、生理学の分野が一応整ってそれぞれ独自の研究も行われるようになったが、その他の分科はこれよりかなり遅れて始められた。すなわち細胞学は明治 42 年頃から、生態学は明治 43 年頃から、また遺伝学はさらに遅れて大正 5 年頃からといえる。これらの研究結果は毎月開かれた植物学会例会の席上で発表され、また植物学雑誌に掲載されたものが多かった。

植物学研究施設の充実 明治時代は植物学の研究は主に東京の大学あるいはその出身者を中心と

して行われたといっても差支ない。しかし、農・林業試験場などでも植物学上の研究が行われていた。それは東京以外に大学が未だ無かったからである。もっとも高等師範学校もあり、また明治30年に京都に帝国大学が設置され（このとき帝国大学は東京帝国大学と改称された）、ついで東北帝国大学、九州帝国大学が設置されたが、東北帝国大学農科大学のほかには植物学専攻科がなかった。

しかるに大正7年大学令が布かれるに及び、各種の大学が昇格または新設せられ、それに伴って高等学校も増設せられるにいたり、今まで設けられていなかった植物学科あるいは生物学科が各大学に設置されるようになった。すなわち大正8年京都帝国大学を皮切りに、東北帝国大学、台北帝国大学、東京文理科大学、広島文理科大学、北海道帝国大学の順で理学部、文理学部、農学部などにこれらの学科が設けられて植物学の教授と研究が行われるようになり、また高等学校などにおける研究施設も次第に整えられ、一方私設研究所として大正7年徳川生物学研究所が置かれるなど、わが国の植物学は東京以外でも盛んに行われるようになった。この頃から科学振興の声が高くなり、文部省、帝国学士院、日本学術振興会などから研究費の助成が行われ、植物学のみならず各科学が盛んになった。その結果、研究業績が多くなり、それを発表するために各大学に紀要類が発行されるに至ったが、植物研究雑誌、日本植物学輯報のような全般的な雑誌の外に、遺伝学雑誌、アクタフィトキミカ、キトロギアなどの専門分科の雑誌が発行されるようになった。しかし植物学雑誌は相変わらず全般的雑誌として全国的に利用されていた。この頃は独創的論文が多くなり、雑報的の記事は次第に少なくなってきた。

日本植物学会と改称 このようにしてわが国の植物学界も東京中心から次第に全国的に拡がってゆき、もはや東京の名を冠する時機がすぎたので、昭和7年を期して日本植物学会と改称された。これはその年が東京植物学会創立以来50周年に当たったことに因んだのであったが、実際の事務は引き続き東京で行われた。この年の4月東京上野科学博物館で50周年記念大会が開かれ、各地から会員が集まり2日間にわたって講演会が催され、見学も行われた。植物学会でこのような大会はかつて明治32年東京でと昭和2年仙台でと催されたが、

ともに思い付きによるその時限りであったが、この50周年大会では今後も毎年大会を催すようにという声があったのも、わが植物学界が全国に拡がった頃であったので当然の要望でもあった。

大会 50周年大会の要望にこたえて翌8年にも大会が行われ、さらにその翌9年にも続行されたが、翌10年にはじめて京都で大会が行われ、以後東京と地方各地と交互に行うことが年中行事になった。そうして昭和10年の京都大会のとき第3回大会と回数を入れはじめ、これがそれから毎年回数を入れることとなった。これらの大会には各地から多くの会員が集まり、講演会を催す外に、附近の見学旅行をも行うことがあり、会員間で議論を行ったり、話し合ったりして相互の親睦を次第に増して行くのに役立った。なお東京では毎月例会を開いて講演が行われていた。

戦争の影響 昭和13年の日支事変の勃発につづいて16年末の英米国への宣戦となった頃は資源科学研究所、木原生物学研究所、名古屋帝国大学での生物学科の設立などが行われ、事変や戦争による影響がさほど大きくもなかったが、次第にその影響が大きくなり、学校における学年短縮、学徒動員がしばしば行われ、物資不足、食料難が次第に迫ってきたとはいえ、昭和18年までは植物学雑誌の発刊もどうやら行われ、大会も同年第18回大会が京都で行われた。しかしその翌年には万事が悪化し、植物学雑誌も3月号を以て印刷が不能となり、交通事情も極端に悪化したので同年の大会も中止のやむなきに至った。この状態は翌年の終戦の時まで続いたのみならず、各地の空襲で大会はおろか、東京における月次例会もほとんど休止され、植物学雑誌のみならず、その他の多くの雑誌もほとんど休刊となった。そのため植物学雑誌は昭和20年には発行されなかった。

この影響は終戦後次第に薄らいでいったとはいえ、植物学雑誌の発行は遅刊した。これは一力戦後におけるインフレのためでもあって、植物学会の会費は年々増額されたが雑誌の発刊が容易でなかった。これを助けたのが文部省の助成金の交附であった。また大会も昭和22年までの4年間は開かれなかった。

大会の復活と支部の結成 昭和23年4月、戦災をうけなかった京都で戦後初めての大会が開かれ、各地から多数の会員が集まったが、これを契

機として以後再び毎年大会が各地で開催されるようになった。この京都大会で支部結成のことが決まった。これは当学会が名実ともに全日本の植物学会となったため、50 名以上の会員をもつ適当な地域毎に支部を設け、講演会などを催すことができるようにしたもので、差当り北海道、東北、関東、中部、近畿、中国四国、九州に支部を設けることとし、本部を東京に置き、従来東京で行っていた例会を関東支部の例会に切換え、各支部でもそれぞれ例会あるいは支部大会を催すところが多くなった。のち中部支部から北陸支部が分離した。

新制大学の発足 戦後における学制の大改革、すなわち 6・3・3・4 制の実施に伴い、昭和 24 年にいわゆる新制大学が発足し、官公私立の大学が各地に設置せられたが、既設の九州大学と大阪大学に生物学科が設置せられたのを皮切りに、新しい大学の多くにも生物学あるいは植物学の専門学科が置かれるにおよび、植物学専攻生が多くなった。この実施以来目未だ浅いとはいえ、近く新博士も生れる筈なので、今後植物学の発達がいよいよ盛んになることが期待される。

このような大学の分散的發展に伴い、各大学に紀要のような研究報告書が刊行せられたとはいえ、全国的な植物学雑誌や大会が却って必要となり、植物学雑誌も順調な発行をつづけ、大会も毎年開かれて互に討論談合の機を与えた。

75 年の回顧 日本植物学会の過ぎ去った 75 年の跡をふりかえて見ると、幾多の変遷、浮沈があったが、それはわが国における国運の興廃とともに植物学の発達過程、とくに大学教育の発達過程をそのまま反映したものといえる。その見地から本学会の辿った跡をいくつか時期に分けて見ると：――

1. 明治から大正中頃までの期間（およそ 35 年間）この期始めは東京大学開設に伴って東京植物学会の生れた頃で混沌時代であったが、次第に独自の研究が行われ、さらに諸分科が興り一応植物学の体制が出来上った建設時代であった。この期は東京中心のときであり、植物学雑誌が中心的な専門雑誌であった。

2. 大正中頃から戦時までの期間（およそ 25 年間）この期は東京以外にも大学が設置せられて植物学の教育研究が全国的に拡がり、各分野の植物学が発達して一応世界的水準に近づいてきた時

代であった。この期は全国的のときであって、日本植物学会と改称され、また毎年全国大会が開かれるようになった。

3. 戦争時代（およそ 5 年間）戦争の影響により諸機能が麻痺し、植物学会の機能もほとんど頓挫した時期であった。

4. 戦後の期間（およそ 10 年間）戦争の影響が次第に癒え、大会の復活、支部の設置、新制大学の発足などにより、植物学会が新しい路に進んできた時期である。

すべての期間を通じて行われた本会の事業の主なもの 2 つある。その 1 は講演会の開催、その 2 は植物学雑誌の編集発行であった。

講演会は本会創立当時から行われたもので、これによって互に知識を普及向上したことが大きかった。もちろんこれは東京において行われたので、参加者も東京近在の人であったものも止むを得なかった。終戦の頃までこの状態が続けられたが、終戦後支部の結成にともなって、講演会が各支部ごとに行われるようになったのはむしろ遅きに失したかもしれない。これとは別に創立 50 周年記念大会を期として毎年各地で全国大会を催すことになった。もっともその前に東京と仙台で大講演会が行われたことがあったが、50 周年大会以来、戦争中の止むを得ない時期をのぞき、毎年大会を開くこと 23 回、その内分は東京 11 回、京都 4 回、札幌 2 回、福岡、仙台、名古屋、鶴岡、金沢、広島各 1 回であった。

植物学雑誌の編集発行は本会創立より 5 年遅れて始められたが、さきめて順調に発展を続けた。始めのうちは啓蒙的、雑報的の記事であったが次第に独創的論文が加わって学術雑誌の体裁を整え、さらに論文が主となり雑報的の記事が副となり、昨今ではほとんど論文を以て占められる状態となった。この間 70 巻を算えるが、昭和の始め頃には最も膨大な雑誌となり、昭和 8 年 47 巻からの 3 巻は 900 頁を越した。これに反し、戦時中および終戦後は時局に禍されて学術雑誌の印刷がほとんど不可能となり、ついに昭和 20 年分は休刊の止むなきに至つたが、終戦後は文部省の刊行助成金をうけて次第に恢復し、昨今ようやく平常にもどった。

外国の植物学雑誌と植物学会 東京植物学会が発足した頃には外国には既にいくつかの植物学会

があり、その多くは機関誌を発行していた。また学会とは関係なくいくつかの植物学の雑誌が発行されていた。発行の順にその主な例をあげれば:-

- 1787 Botanical Magazine, London
- 1818 Flora, Regensburg
- 1824 Annales des Sciences naturelles--Botanique, Paris
- 1843 Botanische Zeitung, Berlin
- 1854 Bulletin, Soci  t   botanique de France
発行
- 1858 Jahrb  cher f  r wissenschaftliche Botanik, Berlin
- 1862 Bulletin, Soci  t   royale de botanique de Belgique 発行
- 1863 Journal of Botany, London
- 1866 Botanisk Tidskrift, Dansk Botanisk F  rening 発行
- 1880 Botanisches Centralblatt, Cassel

などがある。これらの大部分はすでに論文を掲載していた。ゆゑに本会創立の頃はこれら雑誌の内容を抄録したりして、次第に知識を得、やがてこれらの雑誌並みに追いついたのは大正の始め頃の第 30 巻前後といえよう。

また外国の植物学会のうち、主なものの生い立ちを拾って見ると:-

フランス植物学会 Soci  t   botanique de France は 1854 年 4 月 23 日 Paris において創設せられ、直ちに機関雑誌 Bulletin de Soc. bot. France を

発行し、毎年各地で大会を開いて今日に及び、今年には 103 周年にあたり、Bulletin は 104 巻を発行している。またドイツ植物学会 Deutsche Botanische Gesellschaft は 1882 年 9 月 16~19 日 Eisenach においてドイツ、オーストリア、スイスの植物学者の集まりで創立せられ、翌年から機関誌 Berichte d. Deutsch. Bot. Gesell. を発行し、毎年各地で大会を開いて今日に及んだが、第 2 次大戦中大会、雑誌発行が中止されたため、今年には学会創立 75 周年にあたるが雑誌は 70 巻を発行している。これは本会の歴史および植物学雑誌の巻数と一致している。降ってスウェーデン植物学会 Svenska Botaniska F  reningen は 1907 年 2 月 16 日 Stockholm において創立せられ、直ちに機関誌 Svensk Botanisk Tidskrift を発行して今日に及び、今春 50 周年記念式を行い、雑誌は 51 巻を発行している。

このように一国を代表する植物学会はフランス植物学会の 108 周年となったのを四頭として、ベルギー植物学会、デンマーク植物学会について、75 周年の歴史をもつわが日本植物学会とドイツ植物学会を挙げることができ、本会は植物学会としては古い歴史をもってきたことを物語るもので、しかも外国より遙かに低い水準のところに本会をつくり、これを盛り上げた先輩諸氏の偉大なる見識と努力とに敬意を表する。そうしてこれを今後盛り上げて世界の植物学会となることを期待するものである。

日本植物学会75年略年表

「小倉謙編」

年	会長(会頭)	植 雑	大 会	植 物 学 関 係	備考, その他
1882 明治15	会頭 矢田部良吉			2月25日東京植物学会創立 ドイツ植物学会創立	Koch コレ ラ菌発見
1883 明治16	"				
1884 明治17	"				
1885 明治18	"				
1886 明治19	"				帝国大学令 公布
1887 明治20	"	2月15日植物学 雑誌創刊			
1888 明治21	"	植雑2巻			
1889 明治22	"	植雑3巻			
1890 明治23	"	植雑4巻		植雑4巻 44号矢田部声明	
1891 明治24	会長 松村任三	植雑5巻(この 巻に限り左横組)		Engler Syllabus d. Pflan- zenfamilien 創刊	濃美地震
1892 明治25	"	植雑6巻		アメリカ植物学会創立	
1893 明治26	"	植雑7巻			
1894 明治27	"	植雑8巻			日清戦争
1895 明治28	"	植雑9巻			日清戦争
1896 明治29	"	植雑10巻		イチモウ・ソテツ精虫発見	
1897 明治30	"	植雑11巻			
1898 明治31	"	植雑12巻			
1899 明治32	"	植雑13巻	4月総集会		
1900 明治33	"	植雑14巻		メンデル法則の再発見 4月懸賞論文授賞	
1901 明治34	"	植雑15巻			
1902 明治35	"	植雑16巻			
1903 明治36	"	植雑17巻		Johannsen 純系説を提唱	
1904 明治37	"	植雑18巻			日露戦争
1905 明治38	"	植雑19巻			日露戦争
1906 明治39	三好 学	植雑20巻			
1907 明治40	松村任三	植雑21巻		スウェーデン植物学会創立	
1908 明治41	三好 学	植雑22巻			
1909 明治42	松村任三	植雑23巻	4月小野蘭山 百年記念会		
1910 明治43	"	6月蘭山記念号 植雑24巻			
1911 明治44	"	植雑25巻			
1912 明治45	"	植雑26巻			
1913 大正 1	"	植雑27巻			
1914 大正 2	"	植雑28巻			
1915 大正 3	"	植雑29巻			世界大戦始 まる
1916 大正 4	"	10月松村記念号 植雑30巻			
1917 大正 5	"	植雑31巻		植物研究雑誌創刊	
1918 大正 6	"	植雑32巻			
1919 大正 7	"	植雑33巻		徳川生物学研究所設立 京都帝大理学部生物学科開設	世界大戦終る 大学令公布
1920 大正 8	"	植雑34巻			
1921 大正10	"	植雑35巻		東北帝大理学部生物学科開設・遺伝学雑誌創刊	

1922 大正11	松村任三	植雑36巻		アクタフィットキミカ創刊	
1923 大正12	三好 学	植雑37巻		日本植物学報創刊	関東震災
1924 大正13	"	植雑38巻			
1925 大正14	"	植雑39巻			
1926 大正15 昭和 1	"	植雑40巻 (この 巻以降左横組)		第3回汎太平洋学術会議開 催	
1927 昭和 2	"	植雑41巻	7月臨時総集会 (仙台)		
1928 昭和 3	"	3月藤井記念号 植雑42巻		台北帝大理農学部生物学科 開設	
1929 昭和 4	"	植雑43巻		東京・広島文理科大学植物 学科開設・キトロギア創刊	
1930 昭和 5	"	植雑44巻		北海道帝大理学部植物学科 開設	
1931 昭和 6	"	植雑45巻			
1932 昭和 7	"	植雑46巻・4月 50周年記念号	4月50周年記 念大会	日本植物学会と改称	
1933 昭和 8	"	植雑47巻	4月大会(東京)	植物分類地理創刊	
1934 昭和 9	"	植雑48巻	4月大会(東京)		
1935 昭和10	"	植雑49巻	4月3回大会 (京都)	生態学研究創刊	
1936 昭和11	宮部金吾	植雑50巻	4月4回大会 (東京)		
1937 昭和12	藤井健次郎	植雑51巻・5-6 月柴田記念号	7月5回大会 (札幌)		日支事変始 まる
1938 昭和13	柴田桂太	植雑52巻	4月6回大会 (東京)		
1939 昭和14	"	植雑53巻	4月7回大会 (福岡)		
1940 昭和15	田原正人	植雑54巻	4月8回大会 (東京)		
1941 昭和16	中井猛之進	植雑55巻	10月9回大会 (仙台)	資源科学研究所設立	太平洋戦争 始まる
1942 昭和17	柴田桂太	植雑56巻	10月10回大会 (東京)	名古屋帝大理学部生物学科開 設・木原生物学研究所設立	
1943 昭和18	"	植雑57巻	10月11回大会 (京都)		
1944 昭和19	"	植雑58巻			
1945 昭和20	"	(昭21印刷完了)			第2次世界 大戦終る
1946 昭和21	小倉 謙	植雑休刊 植雑59巻 (昭22印刷完了)		染色体発刊	
1947 昭和22	"	植雑60巻 (昭24印刷)		国立遺伝学研究所設立	
1948 昭和23	"	植雑61巻 (昭24印刷完了)	4月12回大会 (京都)	支部結成	
1949 昭和24	"	植雑62巻	4月13回大会 (東京)		新制大学発 足
1950 昭和25	"	植雑63巻	4月14回大会 (名古屋)	4月植物選集発行	
1951 昭和26	"	植雑64巻	11月15回大会 (東京)	11月植物の世界発行	
1952 昭和27	"	植雑65巻	9月16回大会 (鶴岡)		
1953 昭和28	"	植雑66巻	10月17回大会 (東京)	8月植物学の概観(1940- 45)編集・10月ツェンペリ ー記念講演	
1954 昭和29	"	植雑67巻	10月18回大会 (金沢)		
1955 昭和30	服部静夫	植雑68巻	10月19回大会 (京都)	日本生態学会誌発刊	
1956 昭和31	"	植雑69巻・10- 12月小倉記念号	10月20回大会 (広島)		
1957 昭和32	"	植雑70巻	7月21回大会 (札幌)	9月国際遺伝学会議開催	
			10月75周年 22回大会(東京)	10月国際酵素化学学会議開催	

記念講演

大正以降の学会餘談

篠 遠 喜 人

日本植物学会の 75 周年記念大会をお祝い申し上げます。小倉大会会長から学界余談をはなすようにお話がありましたが、なかなかこれという余談もありません。大正のはじめからの“植物学雑誌”(第 26 巻から)をみましたが、余談とか裏話などはそうあるものではありません。そこで“植物学雑誌”とか学会例会とかを中心に、すこしばかり表話を申し上げることにしました。私がじぶんで見たことがおもになり、また先生がたに失礼になることもあるかとぞんじますが、そのときはお許しを願います。

大正元年(1912)から昭和 32 年(1957)までの 45 年のあいだに、学会がであった大きな危機とでもいうものはすくなくも二つはあったと思います。一つは関東大震災にあったときであり、一つは大東亜戦争のときであります。

大正 12 年(1923)の関東大震災のときは“植物学雑誌”の 6 月号ができたときでありましたが、すべて焼いてしまいました。しかし幸に校正刷が残っていましたので、すぐに再刷ができました。つぎの 7-12 月号は合冊として刊行しました。

つぎは大東亜戦争のときですが、この大戦は昭和 16 年(1941)にはじまり、昭和 20 年(1945)に終わっています。第 11 回大会が京都市で開かれたときには、国民儀礼を行い、大東亜戦下本学会の態度を表明した決議をしています。

“植物学雑誌”は第 58 巻(昭和 19 年 1944)のころから発行がむづかしくなりはじめました。紙の配給も統制されました。1 月号は、本文はたった 14 頁で、服部新佐さんと奥野春雄さんとの二つの論文をのせ、会員名簿 22 頁をそえています。2 月号は 38 頁で、吉村フジ、向坂道治、Segi-Tosio、服部新佐の 4 氏の論文と、横織理一郎、猪野俊平、田口亮平 3 氏の雑録がのっています。3 月号は 30 頁で、湯浅 明、服部新佐両氏の論説と、西内 光氏ほか 10 篇の雑録がのっています。表紙は白のザラ紙となっています。

これでもまだよいほうで、これからはいよいよむづかしくなり、4-9 月号(688-690 号)は翌年の昭和 21 年 5 月になってやっと刊行していま

す。和田文吾、木村陽二郎、神谷宣郎、盛永俊太郎、栗山英雄氏による 4 論文がのり、総頁数はたった 10 頁であります。巻末にはこうなった“おことわり”がのっています。この第 58 巻はすべてで 92 頁ですが、昭和 9 年(1934)の第 48 巻が 1009 頁で、10 倍以上であったことを思うと感無量であります。昭和 21 年からは 2 号合併で隔月発行となり、これが第 67 巻(昭和 29)までつづき、第 68 巻からは月刊にかえりました。

さて私はどうしたわけか、関東大震災のときは編集幹事であり、大東亜戦争のときには幹事長でありました。そして前のときは柴田桂太先生が幹事長で松村任三先生が会長であられ、後のときは柴田先生が会長であられました。

昭和 21 年度からは会長は小倉さんで、幹事長は前川文夫さんがなられ、“植物学雑誌”の第 59 巻(120 頁)や第 60 巻(113 頁)のこんなな刊行をつづけられました。このころは印刷所も栃木県や長野県にまでもうつっています。

この大戦のころになくなられた会員の方々は、“植物学雑誌”にのっているだけでも(昭和 18-28 年)つぎのようでありました(敬称略)。

市村 塘、梅村甚太郎、岡田要之助、緒方正資、小原亀太郎、川村清一、高橋章臣、寺崎留吉、鳥羽源蔵、福山伯明、堀正太郎、付本修三、松山秀三、吉永虎馬、吉村文五郎、阿部広五郎、今井喜孝、乾 環、岡村周諦、小泉秀夫、近藤万太郎、白沢保美、田代善太郎、辻部正信、久米道民、山本由松、池田政晴、高橋健治、戸田康保、山羽儀兵。

“植物学雑誌”についてもうすこし申しますと、第 35 巻(大正 10 年 1921)までは 1 頁の組がワクでかこまれていかにも旧式な観をもっていました。このワクが第 36 巻からとりはずされました。この張本人はじつは私でありました。これについては牧野富太郎先生にすっかりしかられて、あるとき東海道の汽車の中で先生からワクの重要性をさとされたことをおぼえています。そのご第 40 巻からは横組にかわり(むかし一度横組になったことがあります)今日におよんでいます。また第 55 巻(昭和 16 年 1941)からは大きさの規格が 46 倍版(199 mm×258 mm)から B 列 5 番(182 mm×257 mm)に変わりすこし小さくなっています。

大会はさきほど小倉さんが学会の歴史の中でお話しになりましたように、昭和8年(1933)4月東京で第1回がひらかれ、今回の第22回(1957)までまず順調におこなわれていますが、昭和19-22年のあいだには大会がなく、昭和23年(1948)4月に京都市で第12回大会が開かれています。なお昭和7年には本会50周年記念大会がありました。

第1回大会には講演数は23で、懇親会出席者は64名でありました。今回の第22回大会では、講演数は200以上で、参加者は約400名であります。また会員数は大正元年(1912)には403名でありましたが、今年は約1150名にたっています。

大会は順調におこなわれたと申しましたが、ここに一つの余談があります。これは小倉さんが提供されたものですが、昭和10年4月に京都市で第3回大会があり、郡場寛先生が大会会長で開くことになりました。ところがどうしたわけか東京からは会長も幹事長も幹事も出席しなかつたため、京都の人たちに大いにおこられたという話です。もっともあとで、近藤武夫幹事がただ1人いていたことがわかり、やっと面目をつないだというわけでした。

つぎに学会例会から二つ三つひろってみましょう。毎月の例会は月次会ともいいました。はじめは植物学教室が小石川植物園の中にありましたから、そこでたいてい開かれましたが、のちには教室が本郷にうつり、例会もあちらで開かれることが多くなりました。

はじめのころは、松村任三、藤井健次郎、早田文蔵、中井猛之進というような先輩の先生方のお名前がたびたびでてまいります。

松村先生は、植物の和名の語原をふかく研究され、和名の多くは支那字音、広東音より転化したものであることをとなえられ、大学の講義でも、学会の例会でもたびたびお話をされました。ハナメガネをかけたりはずしたりされながらたいへんおもしろく話してくださったものです。

たとえば、大正3年(1914)1月24日の例会(小石川植物園)では、つぎの講演をしておられます。

なでしこ及びなづなノ語源ニ就テ

ここでのお話によりますと

なでしこを夏之花(ナツシコ)よりの転化とするのはあやまりで、牙齒花(Ngat-shi-ko)の広東音よりきたものである。また、なづなも牙茹(Nazu-na)の広東音で、葉縁の歯状をあらわすものである。

つぎに思いだされますのは、藤井先生ですが、先生は例会でたびたび講演をしておられます。ことに大正8-10年(1919-1921)の遺伝単位に関する一連の発表は私ども学生にはおどろくべきものでありました。

たとえば、大正8年12月13日には

因子(factor), 概念及ビ遺伝子("id", panggen, biophore), 変化性問題ニ関スル考察

の題で講演され、つづいて4回の講演をへて大正10年10月29日の例会では

生活現象及ビ遺伝単位物質研究ノ基礎トシテノ「エリプソン」研究統観

を講演されました。これらの研究で先生は遺伝単位体としてBionをとえ、これが無生物にもみられるというのでEllipsonと名をかえられましたが、このころの先生の熱意は、私どもに深い感動をあたえました。藤井先生は研究結果をたびたび例会で発表されましたが、これを活字にすることはすくなく、先生の“不出版癖”は有名でありました。

早田先生の植物分類学における動的体系説はこれまた有名で、私ども若いものはそのむしろ悲そうな先生の態度にうたれたものでした。早田先生は例会で講演されるとともに、文章としても“植物学雑誌”に発表されましたし、英文で別冊としても発表されました(The natural classification of plants according to the dynamic system. 1921)。またその著“植物分類学”第1巻(昭和8年1933)や第2巻(昭和10年)でも論じておられます。

早田先生の講演はいくつかありますが、ここではつぎのものをあげておきます。

大正9年(1920)9月25日の例会で
自然分類ノ動的体系ノ組織ヲ説明ス

早田先生は大学の講義でも熱心に自説を強調されました。ところが私どもの同級に山本宣治君がいました。動物学専攻で、のちに代議士となり、“山宣”といわれて有名でしたが、暗殺されました。頭もよく考え進んでおり、親切な人でした。

山本君は早田先生の新学説にたいして鋭い批判の文章を一度ならずかきました。“理学界”などにもでたと思います。早田先生はこれらをよまれたかどうかはしりませんが、いろいろと自説に批判のあることをさられたのでしょう。あるとき教壇から手を大きくつよくふりながら大声でさげられたのです。

“若きものよ来たれ!”
と。

小石川植物園の教室では、私は島地威雄君、杉浦寅之助君その他の学生仲間と一つの室にいました。それが早田先生のおへやのとなりで、たまにのぞくと先生は熱生にシダ類の中心柱の骨格をていねいにほりだしておられるのがみえました。ときどき大きな特有なセキばらいがきこえます。日本人には考える科学者がすくない中に、とにもかくにも早田先生は Denker であると、私たちは話しあったこともあります。

あるとき中井先生が私どものへやに入ってきて話しておられるうちに、話がとなりの早田先生のことにうつり、中井先生のことですから話はすこし手ごわいものでした。お話中、手をあげてじぶんの頭を指でさされながら、小声で“ここがネ”といわれたのです。すると、まさか厚い壁をへだててきこえたわけではないでしょうが、とつぜんとなりのへやから、“オホーン”という大きなセキばらいがきこえてきて、おどろいたということもありました。

大正 9 年 (1920) 12 月 11 日の例会のとき、石川光春先生が

にが属ノ染色体ニ就イテ

の講演をされ、中井先生が発表された四つの新しい属と染色体の上からよく一致するといわれました。すると中井先生はたって、細胞学と分類学との一致におどろくといって喜ばれたのです。ところが早田先生がたって、細胞学とか血清学とかは分類学と一致するものではないと反対されました。このころは例会の議論もさかんだったようです。

昨日の午後ここに Cytotaxonomy のシンポジウムがありましたが、もし早田先生がこれをきいておられましたならば、“若きものたちよ、まだそんなことをやっているのか”とさげられたかも知れません。

とにかくこのころには、このほかに早田先生の

台湾植物の研究とか、中井先生の朝鮮植物の研究とか、また柴田桂太先生の植物のフラボンの研究とか、中野治房先生の浮島の生態学的研究とかいうような、大がかりな研究があって、私ども若いものを感じさせたりはげましものでもあります。

最後に私じしんに関することを一つ申しあげることをおゆるしねがいたいとぞんじます。

“植物学雑誌”第 44 巻 (1930) の 368 頁に、昭和 5 年 (1930) 6 月 7 日の例会記事がでています。その日は小倉さんが

欧米帰朝談、特ニ化石植物ニ就テの講演をしておられます。そのあとにこんなことが記してあります。

“尙ホ兼テ予告アリシ篠遠喜人、向坂道治両君ノ「系統植物分類」ニ関スル講演ハ両君ノ都合ニヨリ中止”。

なぜ中止したかというところに、たぶんみなさんのごぞんじないような裏話があるわけで、やっとな私の話も余談になどついたというわけです。

その前の月の 5 月号の“植物学雑誌”(第 44 巻第 52 号)に向坂道治・篠遠喜人共著で、

植物ノ系統分類ニ関スル考察、第一報 門、亜門ノ標徴ニツイテ(予報)

という論文がのっています。この論文について 6 月の例会で話すことになっていたわけです。論文ののった雑誌がまだでないまえであったかと思っています。ところが向坂君と私は中井先生によびつけられてたいへんにしかられました。おまえたちは分類学の素人のくせにというわけで、いろいろといいきかせてくださったわけです。向坂君は先生といいろいろと議論をしたようでしたが、私は小さくなっていました。

それでも 2 人は若気のいたりで、まだ講演はやるつもりでいたらしかったのですが、こんどは藤井先生によびつけられました。君たちがいろいろと考えるのはよろしいが、中井君にさからってまで講演をすることはやめたほうがよいと、さとされてしまったのです。そこで中止ということになり、そのことを幹事に申しいましたが、病気でなし、そこらにうろうろしてはみつかるというので、2 人で中央線にのって信州上諏訪の私の姉の家に亡命してしまいました。そして温泉にひたっていたというわけです。

これで余談をおわることにいたします。

明治時代の学会の思い出

草野俊助

私は会員中の最長年者の1人として明治時代の東京植物学会のことを想い起して見たい。

しかし植物学会の生れた頃は私は未だ小学生の頃であったのでその頃のことは直接には知らない。先づその頃の学校制度を話すからそれによってその当時の学会のことをしのんでいただきたい。

私は福島県の田舎で生れ、明治13年に小学校に入学したが、校舎といっても寺小屋式の所で神社や寺をつかった所もあり、文部省の教科書を使い、珠算などもやった。中学校は県庁所在地にあったのでそこで学んだが、その学校も仮校舎であった。その後仙台の第二高等中学校に入ったがここで始めて新校舎に入った。そうして明治29年に上京して帝国大学の理科大学に入ったが、ここでも旧校舎で学び、まもなく小石川植物園の教室に入ったが、これも本郷から移したものであった。このように私は旧校舎で勉強しなければならなかったのは、明治維新の事業が未だ完成しないための影響であったと思う。

小学生のころは正式の先生が間に合わず、神主や漢学者が先生になっていた所が多かったが、次第に師範学校の卒業生が各学校に多くふえてきた。中学校のころは高等師範学校や高等工業学校の卒業生がおったので、教授内容も次第に整備さ

れてき、高等中学校ではじめて学士様の授業をうけた。

このようにして、師範学校、高等師範学校、大学の卒業生が増加するにつれて、小学校、中学校、高等中学校の先生が、丁度私の進級してゆくのと同じような風に殖えてきて充実してゆき、学制が次第に整っていった。

このような訳で、植物学会の創立された明治15年頃には、未だ植物学を専攻する人が殆んどなく、齋田功太郎氏が植物学の最初の理学士となったのは明治18年であったので、20年に植物学雑誌が出るようになったとはいえ、余り難かしいことを書いても解る人が少なかったので、この辺を加減して学会を運営したり雑誌を編集した幹事の人々の苦労は大変であったろうと察する。つまり学界がまだ幼稚であったので、雑誌の記事も高尚な論文が無理で、解説的な記事、例えば沢田駒次郎氏の葉草に関する連続記事のようなものが大いにうけたようであったし、学校の先生にはこういう記事がもっとも欲しがられていたのであったろう。

明治30年以後は私が学会と直接間接の関係が深かったが、この頃になれば明治維新の諸事業が一応おちつき、学校制度が整備し、学会の会員も多くなり、経営も次第に楽になっていった。しかし、雑誌にあらわれた記事には、雑報、雑録、新著紹介、旅行記などが多かったが、これはそういう記事が会員に喜ばれたからで、それはその当時の学界の水準を示しているものといえよう。

特別講演

Adventuring in Japanese Botany

(Summary)

by Egbert H. WALKER*

Many American botanists have dealt now and then with Japanese plants, but few, if any, have ever become as deeply involved as I have. Most have been plant explorers, seeking materials in your mountains, fields, forests, and gardens to enrich western agriculture and horticulture. Because my interest in Japanese botany is different, I shall scan my projects and discuss some of the problems they have presented. The success of this talk will be measured by the discussion it elicits.

This work has largely been carried on at the Smithsonian Institution, where important collections from Japan may be found in the U. S. National Herbarium. Some of these specimens were studied by Asa Gray, the first American who dealt with the botany of Japan, especially on the relationship between eastern Asia and eastern North America. Although the U. S. National Herbarium has many specimens from Japan and the Ryukyu Islands, a relatively large number of reported species from this area are still unrepresented.

Early in my career I worked with the late Elmer D. Merrill in the preparation of "A Bibliography of Eastern Asiatic Botany". Over 700 Japanese authors are among those who contributed the 21,000 works there listed. This bibliography was designed as a tool for all botanists working with eastern Asiatic plants. Hence, its coverage was wide. Unfortunately many oriental titles could be given only in translation, and Chinese and Japanese characters were used to a limited extent. This restricted use of the oriental languages hampers the use of this work by Japanese and Chinese scholars. It is hoped that in the first supplement, the final preparation of which will soon be started, this limitation in the original work can be corrected. This will require closer cooperation with botanists and bibliographers in this part of the world, and probably publication in Japan.

The second project undertaken at Dr. Merrill's suggestion was a "Revision of the Eastern Asiatic Myrsinaceae", involving Japanese species. This led eventually to a coordination of my work with a corresponding work by the late Takenoshin Nakai. This study bore fruit in some understanding of the differences and similarities in western and Japanese taxonomic perspectives. An interesting sideline in these taxonomic studies has been the direct and the indirect contact with many people. In my revision appear the names of over 250 people. If a botanist also likes people, he should be a taxonomist and a bibliographer.

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A deeper involvement in Japanese botany came with the editing soon after the war of a "Flora of Okinawa", which had been prepared by three Okinawan botanists at the request of the naturalist servicemen in the U.S. Army stationed there. The edited manuscript was mimeographed in 1952 by the U.S. Civil Administration in the Ryukyus and the Government of the Ryukyu Islands. At the request of these organizations a new and greatly improved "Flora of Okinawa" is now being prepared. It is being founded on my own collections made in Okinawa and the southern Ryukyus in 1951 and on those of some 80 other collectors, mostly Japanese and Okinawan. It is the furtherance of this project which has brought me to Japan at this time to delve into your herbaria, and for which I shall go on to Okinawa and Taiwan.

Another project in Japanese botany was the preparation of a treatment of over 200 "Important Trees of the Ryukyu Islands", also undertaken at the request of the U.S. Civil Administration in the Ryukyus. It has likewise brought me close to problems in the botany of this area, thus furnishing valuable experience for the more technical flora now in preparation. It was profusely illustrated by line drawings. It was translated into Japanese by the Okinawans and was published in 1954 with Japanese and English text in parallel columns, thus making it a useful work in Okinawan schools. On the title page my given name appears in Japanese "kana", my middle initial as an English letter, and my family name in Chinese, thus rendering me nomenclaturally as a triple hybrid. I am grateful that the taxonomists' abhorrence of such nomenclatural barbarisms applies only to scientific names of plants, and not to those of authors. I feel honored to be so linked to three great cultures.

In order further to promote greater accord between Japanese and western botanists one more project in this field is being carried out. This is the editing, along with Fred Meyer, now with the U.S. Department of Agriculture, of an English translation by Jisaburo Ohwi of his "Flora of Japan", published in 1953 in Japanese. This will be the comprehensive treatment of the Japanese flora in any western language since 1879. Because of the interest of the National Science Foundation in promoting cultural interchange of this nature, that organization has provided funds for the preparation of the manuscript of this English edition.

It is the aim through these endeavors to help to bring the botanists of Japan and of America and the west into closer understanding and cooperation. May we soon eliminate the terms Japanese botany and American botany, and have only botany and botanists, working together in pushing back the boundary between the known and the unknown toward its ultimate extinction,

中華人民共和国における植物生理学の現状

(摘 要)
羅 宗 洛

1949年解放前の中国においては、植物生理学の研究機構として次のようなものがあった：

前中央研究院植物研究所 植物生理組(1944-1949),

清華大学農業研究所植物生理組(1938-1946),

北京大学前中央大学, 浙江大学の生物学系,

ただし、それらの機構では設備もきわめてわるく、職員もわずかであった。

解放後、ただちに機構の改組に着手し、優秀な人材を集め、こうして、植物生理学の研究が次第に本格化して来た。すなわち 1953 年に中国科学院植物生理研究所が設立され、ひきつづいて今年には中国科学院北京植物生物研究室も成立したのである。このほかに中国農業科学院に属する各研究所、各綜合大学、各農学院にそれぞれ植物生理研究組、もしくは植物生理教研組ができて研究が進められている。

研究概況

主として中国科学院植物生理研究所において行われている仕事を申しあげると――

水分生理組 不良環境における植物の抵抗性の研究を行っている。(1) 苗木の耐塩性の測定、(2) 違った發育時期における水稻の塩水灌漑について、(3) 種子処理による苗木耐塩性の増進、(4) 植物耐塩性に対する土壤含水量の影響、(5) 塩土中の死苗の原因、(6) 水稻および小麦の冠水試験、(7) 水稻および小麦の耐旱鍛煉などの研究が進められている。

鉅物營養生理組

1. 違った發育時期における小麦の N および P に対する需要 分蘗期に追肥を与えると分蘗数と小穂数は増加し、shooting stage に追肥を与えると葉の長さ、千粒重したがって収量が増加する。これに反して heading stage に施肥すると成熟はおくれて千粒重したがって収量も減少する。乳熟期に施肥するとあまり影響はないが千粒重はやや増加する。このように違った發育時期に植物の養分に対する要求は一樣ではない。

2. 棉の落花落果について 土壤水分の欠乏と窒素肥料の過多は棉の落花落果を引き起こす

条件であるが、一番重要な要素は光であることが分った。光を日光の二十分の一にすればほとんど 100% の落花落果を生じた。光不足の場合に先ず花粉母細胞の發育は阻害されて四分体時期を一步越すことができない。光の不足が果実および花の可溶性炭水化物量に影響しその不足を来たし従って落果を促進することは環状除皮の試験で証明された。一つの花と二枚の葉を有する果枝を環状除皮して十分に可溶性炭水化物を供給すれば未受精の果実でも落ちずに發育させることができた。

發育生理組 この組においては次のごとき研究が進められている。

1. 小麦の性器官形成 春化期を通過した直後は生長点の伸長を見ず、光期を通過しつつ雌雄ずいの形成は完成される。莖生長点の伸長より小穂形成までの間、生長点の分化に対する photoperiod の影響はあまり著しくない。

2. イネの發育時期 南京の氣候条件の下では、春化期を通過したものは早熟品種では通過しないものに比べて 20 日早く、中熟品種では 15 日早く、晩熟品種では 10 日早く出穂する。春化に要する時間は適当な温度においては一般に 12 日を越さない。性器官の分化は、光期を通過した後でなければ始まらない。イネは莖生長点が分化した後に長日の条件の下にも出穂することができる。

3. 植物組織中の硝酸還元酵素および組織培養中のチロシナーゼ 高等植物の組織中に硝酸還元酵素が発見され、殊に大豆の芽生の中に沢さん含んでいる。この酵素は部分的に精製された。人參の癒傷組織の培養基の中に大量のチロシナーゼが存在することが見出された。しかし、人參の根にはこの酵素がわずかししか含まれていない。

生物化学組 主な研究課題は次の如くである。

1. フォスフォリラーゼ、アミラーゼおよびでんぷんの貯蔵 發育中のイネの穀粒におけるフォスフォリラーゼとアミラーゼの活動状況を見た。その結果によると、開花より成熟までの間にこの二つの酵素の活力は乳熟期において最大、でんぷん貯蔵もその時期で最高となり、両者の間に殊にフォスフォリラーゼとでんぷん貯蔵との間に

緊密な相関関係を持つことを示す。しよ糖をでんぷんに転化する時に光は phosphorylation に対して重要な作用をすることが分った。なお C^{14} 、及び C^{14} を含むしよ糖を利用してこの方面の研究を続けている。

2. 光合成 Infrared gas analyzer を使ってイネの葉の CO_2 吸収を連続的に測定した。それによると、光合成の強さと葉の年齢と空気中の CO_2 濃度との間に相関があることを確めた。Hill 反応に関する研究も行っている。

3. 食糧貯蔵 貯蔵のためのイネ、小麦の穀粒の安全水分を地方別に決定した。日光に晒すことは大豆の出油率に影響がないことを証明した。なお農民が多年行って来た「小麦熟進倉法」、すなわち、小麦の種子を日に晒した後、暖い中に倉庫に入れるという除虫法は小麦の品質に影響がない、ただし発芽率の減少を来すことになる。種子の休眠期は貯蔵中の種子の寿命に大いに関係あることが発見されて今その方面の研究が進められている。

MH (Maleic hydrazide) の噴霧で貯蔵中のタマネギとニンニクの発芽を防止し、2, 4, 5-tri-chlorophenoxy acetic acid で貯蔵中のジャガイモの発芽を抑制することができた。こういうホルモンが植物の組織に附着してその呼吸、吸水作用および terminal oxidase に対してどういう影響を与えているかについて研究を行っている。

微生物生理及び生物化学組

1. *Streptomyces aureofaci* の生理と Aureomycin の生成 1) 菌の代謝と aureomycin の産量に及ぼす接種培養基の影響を見た。違った培養基に生長した菌は同一の発酵培養基においても aureomycin の産量が大いに違っている。その際、糖の利用と有機酸の形成も一様でない。2) 産量の低い二つの変異種を混合培養すると aureomycin の産量が大いに増加することを見た。単胞子分離法で混合培養の結果、高産な strain ができたことを示した。3) 培養基中の磷酸濃度の増加によって糖消費の増加、ピルビン酸の貯蔵および aureomycin の減産を来す。この菌の細胞中、炭水化合物の分解に際して Embden-Meyerhof-Parnas (EMP) 経路と hexose monophosphate shunt (HMP) が共に存在し、しかも磷酸イオンの影響で EMP から HMP へ移転する

ことができるということを証明した。4) 発酵の始めにおいては通気は必ずしも必要ではなく発酵を始めてから 24-36 時間に十分の通気を要する。

2. *Eremothecium Ashbyii*, *Ashbya gossypii* の生理とリボフラビンの生成 Riboflavin の生成のためにいろいろなアミノ酸の利用を見た。研究に使ったアミノ酸の中にグリシンと L-アラニンがリボフラビンの生成を刺激することが発見された。

3. *Salmonella typhosa* と *Salmonella paratyphi* B の可濾性形態 クレオソールあるいはペニシリン G を培養基に入れ細菌の細胞を破壊して濾過する。ろ液を取って培養すると二三週間で細胞の形態を回復する。ただし回復した細胞は毒性和免疫性において元来の細菌のそれより低くなった。

4. *Streptomyces griseus* の Actinophage 生物学および物理学的の性質によっていろいろな類型の actinophage を同定することができた。

一 般 講 演

10 月 12-15 日

分類・形態・細胞・遺伝・地理

- 米田 芳秋：フォイルゲン染色による酵母核の研究
 伊藤 太郎：アカパンカビ雌雄接合型にみられた被子器形成に対する NH_4 態および NO_3 態窒素源の有効性のちがい
 馬場 三吾：カルス形成の際におけるフェノール酸化酵素の活性度の変化
 川松 重信：アカウキクサの根毛内の顆粒について
 佐藤 七郎：発芽にともなう TTC 還元様式の変化と細胞構造との関係
 高尾 昭夫：クロマツの胚発生の組織化学的研究
 吉田 吉男：数種の沈水植物細胞における硝酸銀還元反応の検討
 沢村 正五：ムラサキツエクサの花粉粒有糸分裂の生体観察
 和田文吾・山本道子：固定像における紡錘体の界面膜
 保井 コノ：*Crinum latifolium* および *Lycoris sanguinea* の雄性配偶体の発生について

信夫 隆治: 放線菌の1新種 "*Streptomyces spiroverticillatus* nov. sp." について

増田染一郎: 有柄細菌 *Caulobacter* に関する研究 (第2報)

椿 啓介: *Candelabrum* 属の観察

曾根田正巳: 口腔中より分離された酵母菌について

越智 春美: 日本およびその近接地域におけるカサゴケ科の研究 (第11報) *Bryum tortifolium* Funk とその近縁種について

高木典雄・永野 巖: 南アルプスおよび秩父両石灰岩地域のセン類フロラの類似性

安藤 久次: 日本産キヌタゴケ属(*Homomallium*) の分類と生態

鈴木 兵二: 本邦産スギバミズゴケ類について

川崎 次男: シダ胞子の発芽能力

百瀬 静男: 前葉体によるウラボシ科の解釈とその類縁

小宮 定志: タヌキモ科植物に見られる発条形式と器官形成について

及川 公平: ヒロハアマナの胚嚢および胚乳について

深沢 広祐: 異質細胞質による異常気孔について
伊倉伊三美: シダ類造精器における吸水力と透過性

末松 四郎: 寄生性藻類による宿主植物組織の変化

植田利喜造・村上 悟: フイリヤブランの色素体について

植田 勝巳: *Trachelomonas* の細胞の電子顕微鏡的構造

新家浪雄・植田勝巳: ラン藻細胞の endoplasmic reticulum

守屋 忠之: 秩父地方の石灰岩地の植物(第1報)

林 弥 栄: 本土におけるヤチダモとシオジの天然分布

菅原 繁蔵: 日本海諸島の植物分布の概況 (その2)

鈴木 時夫: 九州にあらたに発見されたツハヤキ分布のツツジ属植物について

堀川 芳雄: 本邦における暖帯着生植物

粉川 昭平: ミツガシワの遺体種子の計測による年代推定

三 木 茂: 遺体からみた邦産マツ科植物について

浅野 明: 海岸植物の核学的研究 (第3報)

神野 太郎: キイチゴ属の二三の自然雑種について

稲荷山資生・竹村英一: ヒガンバナ属の人工雑種について

矢野 孝二: セン類の染色体数, 殊に特異な倍数性について

釜野井正男: *Aegilops squarrosa* 同質四倍体と Emmer コムギとの雑種第1代にあらわれた $2n=29$ 植物の染色体接合 (第2報)

善如寺 厚: コムギ-カモジグサ雑種の細胞遺伝学 (第1報) *Triticum durum* \times *Agropyron elongatum* F_1

土屋 工・林 二郎・高橋隆平: 3染色体植物によるオオムギ連鎖群の研究 (続報)

松村清二・根津光也・小柴幸夫: *Triticum georgicum* のゲノム分析

竹本貞一郎: タンポポ属植物の細胞学的研究

藤原悠紀雄: ヨメナ属 (*Aster*) 植物の核型分析 (第5報)

下斗米直昌・益森静生・金子賢一郎: キク属の染色体数にいちじるしい差のある種間雑種

福島 博・小林艶子: 和歌山県白浜温泉のケイ藻 植生

梅 崎 勇: 日本海産ラン藻類について

瀬川宗吉・千原光雄: 緑藻ランソウモドキ属の生活環

沢田 武男: シダモクに関する研究 (追報)

野田 光蔵: *Spermothamnion yonakuniensis* Yamada et Tanaka の形質について

吉田 忠生: カワモズク属の1種の生活環について

広瀬 弘幸: 再びイデユコゴメ *Cyanidium caldarium* の所属について

瀬川宗吉・湖城重仁: 紅藻 *Falkenbergia* の四分胞子とその発芽

加崎 英男: 日本産シャジクモ類 (第11報) *Chara globularia* Thuil. とその変異について
今堀宏三・須賀瑛文: 木崎湖におけるシャジクモ群落と変遷

緒方茂利夫: ノビルの細胞学的研究 特にねん性について

藤 原 勲: *Plantago major* と *P. japonica* との間の生態学的比較

桑 名 替: アカパンカビの2系統間の相互作用による菌体のメラニン化

武丸 恒雄: エノキタケのリンカーゲジ研究

木村 勘二: 帽菌類の diploidisation における核の行動

上野 実朗: マツ科およびマキ科花粉の気嚢の変化

相馬 研吾: ホルトソウの生長点における前形成層の分化について

加藤 幸雄: ゼンマイ胞子の極性と仮根分化

石 上 晃: ヒメジョオンの頭状花の配列測定
中心角をもちいずに3個の頭状花のなす角をもちいる方法

館沢 正夫: 開度と節間長との週期的変化(続報)

山 段 忠: フラスモ遊離細胞の生長成形について(第4報)

阿部重美・中島宏通・神谷宣郎: 原形質流動の原動力と呼吸の同時測定(第4報)

高 田 充: 顕微注射による変形体原形質流動の生理学的研究

中島 宏通: 変形体の収縮性たんぱく質(第2報)

岸本卯一郎: 変形体の電位のリズムについて

森 祐 二: 単一植物細胞の浸透特性(第6報)

永井 玲子: 細胞の浸透調節作用に関する研究(第3報)

岸本卯一郎・赤堀弘道: フラスモの原形質流動と鋤作流との関係について

高 田 充: カサノリ遊離原形質滴の運動について

神谷 宣郎・黒田清子: フラスモ遊離原形質滴の諸性質

神谷宣郎・黒田清子: 周回原形質流動の力学

近衛 康他: メタセコイアおよびその近縁種の菌根について

原 襄: ツツジ科の脈系の発達

斎藤真太郎: セン類のさく歯の発生学的研究(第5報)

西田雄行・斎藤真太郎: セン類の胞子の発芽について(第1報) タマゴケ, ネジクチゴケ, ツリガネゴケについて

菅井道三・原田市太郎: モエジマシダの初期前葉体の生長様式

高橋 千裕: シダの原糸体その他における細胞壁の生長

伊藤 道夫: シダの原糸体細胞の伸長について

堀田 康雄: アミノ酸アナログとヌクレオチド・

アナログのシダ前葉体での2次元分化への影響
野沢治治・野沢ユリ子: オオイシソウの発芽について

中沢 信午: ヒバマタ科藻類の第一次分化について

猪野俊平・西林長朗: コンブ目植物の比較形態発生的研究

田中国治・森岡喬樹: 糖質トウモロコシ胚乳の細胞におけるホスホリラーゼの分布

照 木 勲: アカビートの耐凍性とホスホリラーゼ

朝比奈英三: 原形質膜の防凍性

小田 健二: シャジクモ節間細胞の興奮にともなう膜抵抗および膜容量の変動

柴岡 孝雄: シャジクモの節部をこえる興奮の伝達

平岡 俊佑: フクシン抽出法によるフォイルゲン反応の解析

石田 政弘: フォイルゲン反応に対するたんぱく質の影響

鳥山 英雄: オジギソウの細胞生理学的研究(第9報)

遠藤 沖吉: オジギソウに及ぼす弱光の刺激効果について

沢田 義康: 花粉発芽に及ぼすアミノ酸の影響について

森 隆 也: でんぷん花粉の発芽について

生理・生化・生態

河野 晴也: 暗所におけるユーグレナの炭酸固定について

宮地 重遠・広川豊康・田宮 博: 反応速度論的方法による光合成機作の研究

西崎友一郎: 緑葉の光電反応(第1報) 明・暗期の長さによる反応の変化

中山至大・飛田博温・中村国治: 暗期反応に対する高温と光の効果

藤井 良平: ミトリササゲ幼生の生長に及ぼす赤色光の影響

柴田 治・木下哲雄: 短日効果と培養液中の鉄濃度との関係

長尾 昌之: 生長調節物質試験法(Avena切片法)

の一変法

増田 芳雄：オーキシン作用の原形質学的研究
(第2報)

八巻 敏雄：マカラスムギ子葉鞘の炭酸ガス固定
とこれに及ぼすインドール酢酸の影響

村 上 浩：低濃度のインドール酢酸による子葉
鞘切片伸長の阻害

香山 時彦：靈菌の色および薬物耐性変異をもち
いた二三の実験

高田英夫・徳野真一：食塩耐性酵母菌のナトリウ
ムの結合について

平岡 純一：酵母変異菌のイオン交換性 (第3報)
持塚 洵・芦田譲治：銅耐性酵母の集団組成の変
化

柳島 直彦：酵母菌の W 変異と銅適応

志村令郎・芦田譲治：酵母の高濃度銅耐性

荒 勝 豊：含銅培地における酵母の銅吸着と耐
性の関係について

中村 運・芦田譲治：酵母の銅耐性におけるいお
うの意義

内貴信夫・菊池忠寿・芦田譲治：銅耐性酵母の硫
化水素発生

菊池忠寿・内貴信夫・芦田譲治：銅耐性酵母の亜
硫酸還元

倉石 晉・奥村重雄：カイネチン類縁化合物の葉
の生長促進作用

加藤 次郎：ジベレリン酸の同定方法とその植物
組織内の移動について

加藤次郎・勝見允行：ジベレリン酸のインドール
酢酸破壊酵素に対する影響とインドール酢酸と
の分子間結合について

吉原朝子・小清水卓二：ハマオモト種子の傷口に
形成される色素中の生長作用物質

柴岡弘郎・今関英雅：ヒマワリの葉に含まれてい
る生長阻害物質

田 中 清：アカマツ花粉に含まれている生長抑
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 斎藤 実・佐々木太一：北海道のセンタイ類（第3報）ハイマツ群落におけるセンタイ類
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 小島 均・関岡 行：サツマイモにおける物質移動と温度との関係
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 吉良竜夫・篠崎吉郎：新しい植物生長の理論（その1）生長曲線と生長要因の作用函数
 生嶋 功：新しい植物生長の理論（その2）線型要因（光，土じょう水分，栄養塩類その他）について
 穂積 和夫：新しい植物生長の理論（その3）線型要因間の相互作用について
 佐伯 敏郎：同化組織の垂直分布構造の理論的考察
 倉内 一二：イチョウの発芽，落葉等の個性性について 生物季節とその利用（第3報）
 楠 元 司：常緑広葉樹の光合成の季節変化について
 高橋基生・鎌田久福：切断根系の呼吸の不自然性（第3報）つぎ木ならびに葉の病変の影響
 高橋基生・渡辺匠美：根系呼吸に及ぼす過酸化水素，糖類ならびに有機酸の影響と銅塩の場合との比較
 桑山弥寿男・宇佐美正一郎：イネの発芽期の呼吸系
 寺岡 宏・宇佐美正一郎：コムギの播種性のちがいによる代謝系の相違について（予報）
 松崎悦三・大林弘幸・柴師寺英次郎：コリヤナギのポリフェノラーゼに関する研究
 森 健志・森 久子：種子発芽期におけるプロトヘミン体の分布とその変動
 藤田善彦・服部静夫：ジュウニヒトエの無細胞液によるガラクトース転移反応について
 遠藤 徹：咲き分けツバキのロイコアントシアニン
 柴田万年・堺 惠美：チカラシバの花穂における色素について
 柴田万年・堺 惠美：クロユリの花の色素について
 桃谷 好英：濁度滴定に関する二三の問題（第2報）葉緑体の構成成分の分離
 千葉 保胤：超遠心による葉緑体たんぱく質の研究

一般講演の要旨が残っています。部数僅少ですから御希望の方は至急お申込み下さい。

（一部 200円）

シンポジウム(1, 2) 報告

10月12日 15.00-17.30

前21回北海道大会の折に、新しい試みとして形態学談話会をシンポジウム形式で行うことが決定され、今22回東京大会で初めて行われた。参加者が形式に不慣れなせいもあって、必ずしも成功とはいえなかったが、形態学の広い分野の中から話題を狭く、焦点を絞って討論の形式に持ち込んだことは今後の発展の上にまずまずということである。

「小胞子の発生と類型」の表題、座長佐藤重平氏の下でまず原田市太郎氏(名大・理)が教科書的な区分けのもとに小胞子を研究する場合の分野の分類と、研究材料及びその段階等について問題の所在を指摘された。

上野実朗氏(大阪市大)は「針葉樹の花粉形態」について幻燈を使用され、要旨次の如き講演をされた。

花粉母細胞の分裂は殆ど同時型である。發育中に花粉膜の上部と下部の外皮が離れて気嚢として発達するもの(マツ・モミ・トウヒ・マキ・ダクリジウム等)、発達しないもの(ツガ・コウヤマキ・カラマツ・ナンヨウスギ等)、変化するもの(スギ科ヒノキ科)、その他(イチキ科)となる。属又は種により色々な特徴(背部の三放射線、気嚢及び基部突起の型・数の変化等)を示すが、発生的にみた花粉形態の基本的構造は大差はない。これを典型的に大別するとマツ・マキ型からツガ・コウヤマキ型となり、スギ型をへて、ヒノキ型になったものといえる。イチキ型は尙不明な点が多い。

以上ふたつの話題に対する討論は時間的な余裕がなかった為か、あまり盛り上らなかった。

次いで「花の形成の諸問題」の表題、猪野俊平氏の座長の下に今村駿一郎氏(京大・農)の「伸長と開花」、木村有香氏(東北大・理)の「ヤナギ類の花被」の話題提供があった。今村氏は具体的な例を挙げながら次の如く開花現象と伸長についての根本的な考え方のひとつを出された。

長日植物は短日では茎の節間が伸長せず、花芽形成後伸長するものが多い。これに反して短日植物は開花に伴って伸長を停止する。一方長日植物の花芽形成は外から与へられた生長素によつて促

進され、短日植物のそれは抑制される。これらの事実から生長素の消長が直接花芽形成を起すとも考えられるが花成素の存在も否定し難い。よつて日長は生長素量を左右し、花成素の生成は生長素の適量の存在に於いて起るものと仮定すれば兩種植物の開花反応を一元的に説明することができ。尙花芽形成後の伸長は花部器官の生成する生長素による場合も多い。

この話題に対して北村四郎氏(京大・理)はロゼット葉をもつ材料としてあげられたもののうち一二、疑問のものとがあると指摘されたが、根本問題に対する討論はなかった。

次に木村氏は花を構成する要素に対して実例をあげ次の如く考え方を提出された。

日本植物学会第17回大会で木村有香は従来の自説を補正しヤナギ類の花の腹腺体は前出葉 α 、 β とその中間に加った一個の phyllome とによつて構成されたものであらうと説いた。所がその後菅谷貞男氏はマルバヤナギの花穂柄の下出葉腋及び苞腋に形成される側軸の原基を観察し花穂柄の下部では側軸原基の α と β が反軸側で癒着し γ は向軸側に δ は反軸側に現れるが、上部に向うに従い α と β は向軸側で癒着し γ は反軸側に δ は向軸側に現れ、かくして次第に花部腺体に移行することを証明した。これにより木村が腹腺体構成要員のひとつとした phyllome は δ であることが推定され且つ α と β とが花被の構成にあずかることが明らかとなった。菅谷氏のこの所見は花穂柄の下部より上方花穂部に向うに従い前出葉が位置を変じて花被構成にあずかる一つの著しい例ということが出来る。木村は尙この所見を腺体反軸部に適用し背腺体は γ , ϵ , ζ よりなるものであり、ヤナギ類の花被は元来六員数のものから出發したものであらうと推定した。

尙これに対し熊沢正夫氏はオナモミに於ては前出葉は下部の側枝では反軸側に片寄り、上部に於いては向軸側によることを説明し、この点マルバヤナギに類似することを指摘した。

今後の問題として、形態学は広い分野にわたっているので、シンポジウムに参加する各自が話題提供者と同じ表題の下に勉強して来るか、もしくは表題として共通の興味を持つものをえらびだすかの努力を必要とするのではないか。いずれにしてもシンポジウムを無意味に終らせないようにし

たいものである。

シンポジウム (3. 4) 報告

10 月 13 日 15.00—17.30

3. Cytotaxonomy に関する諸問題 (原寛氏司会) 話題提供 a. 北村四郎氏「キク科植物を材料として分類学の立場から」b. 小野記彦氏「キク科植物を材料として細胞学の立場から」

北村氏は配布の印刷物「東亜キク科植物染色体表」により属 Genus や族 Tribus で染色体数が一定または倍数関係にある事, Babcock の *Crepis* の論文では染色体数の多から少への進化を述べるが, キク科全体でみると多くの形質で *Cynareae* が一番すゝんでいるが染色体数は割に多く, 基本数が 17, 13 であることなどを指摘した。また細胞学者が研究対象とした材料を標品として保存する事を要望した。下斗米直昌氏は標品保存の必要性をまとめ, 倍数関係がキク属でよくなりたつことをいい, 小野記彦氏も標品保存は賛成であるが事実上困難も多いことを述べた。松浦一氏はクロユリの 3 倍体が北海道平地に 2 倍体が北海道と本州との高山にあること, その間には形質の差が少しあること, 平地のもののみ東京でよく育つことを例とし 3 倍体は 2 倍体から導かれたものと当然考えられるとした。佐藤重平氏も菌は染色体数 4 がもとで, これよりみて染色体は少から多への進化が一般的であるとみた。次に小野記彦氏は配布のプリントの荒野氏 (1955 年及び未発表) の「キク科管状花類の核型より見た分類位置の二三の考察」によつて他の形質と, 染色体による核型とを比較し, 分類するに当つて核型を形質の一つとする立場, 核型をすべての形質を代表する形質とする立場, その中間の考えとして一つの形質ではあるが他より重要な形質とみとする立場とあり最後の考えがよいと思うと述べ, そのためには核型で, ヘテロクロマチンを研究する事によつて数のみだれが補正できること, そうすれば核型の安定の度は高いこと, 形の大小や太さは絶対的なものでなく薬品の処理でも変る事, micro-karyotype が低温処理による横縞などで明らかとなり利用度が高いこと述べた。原寛氏はアズマギクは核型によると *Erigeron* であるが *Erigeron* か *Aster* か, と質問, 北村四郎氏は確かに中間的なものである。これをどちらの属にするかは形質のとり方である

とし, 核型を優先的できめる考えを疑問とした。木村陽二郎氏は「小野氏のいわれる如く染色体は形質のカンズメであるが, 中を未だ開かないから, 染色体を培養して増殖させ巨大唾腺染色体にみられるように縞模様をみられるようになれば相応形質として重要となるが染色体の数, 形だけではあまりにも外部形態的で安定はしていてもこの意味がまだわかっていないと述べ, これに対し松村清二氏はゲノム分析などによる遺伝学的方法で染色体の中味もある程度わかることを指摘し分類学者が交配により雑種かどうかをたしかめる実験をすることを希望した。篠遠喜人氏は核型についてもまだ色々問題があり, たとえば染色体数をきめる遺伝子の研究の必要性を述べた。

4. 下等隠花植物の体系と系統 (木村陽二郎司会) 話題提供 a. 瀬川宗吉氏「藻類の体系と系統」b. 小林義雄氏「菌類の体系と系統」

瀬川宗吉氏は配布の印刷物「藻類の体系と系統」「藻類各群の諸形質一覧表」「体系及び系統の図示」「藻類体系の比較表」「文献表」により話をすすめ, 藻類の体系は 4 つの傾向に大別される。(A) Engler-Diels (1936)—池野 (1930)—岡村 (1930)—Harder (1948), (B) Oltmann (1922)—Fritsch (1925, 45), (C) Pascher (1931)—Smith (1938, 55)—Engler Pf-fam. (1954)—Pappenfuss (1955), (D) 前川 (1952)—木村 (1953) がこれである。問題点は藍藻と紅藻が互いに近く, 他とはかなり離れていること, 緑藻と高等植物とは全く近く, 車軸藻の独立性は問題である事, 黄色べん毛類, 褐色べん毛類, フシナシミドロ類の互いの関係についてであることを述べた。また研究はつきないが教育上に用いる体系としてはなるべく多くの人が用い, なるべく全植物を含むもので基準的な教科書にのり教える人が自信をもつことができるのがよいとし, このような体系の例として Smith のものをあげた。つぎに小林義雄氏は印刷物「菌類の体系と系統」によって話をすすめ「菌類とは何か」「菌類は植物か」「菌類と藻類とは似るか」「その間に系統関係があるか」等の問題を提起し, すこし変つた体系の例として Martin (1940), Schussnig (1948) Gäumann (1949) Alexopoulos (1952) Moreu (1954) のをあげた。湯浅明氏は車軸藻は鞭毛よりみてコケ植物に近いし, またイチョウ, ソテツなどにも関係があるように思うか

ら緑藻とは区別されるべきと思うと述べ、三輪知雄氏は構造に関係ある細胞膜は形質としてよいが、機能に関係する同化物質は特徴としてとれるかどうか問題であまり重要視すべきでないとの考えをのべられ、司会者は機能に関係ある物質もこれをつくり出す原形質に関係あり、したがって表示的な形質としてとれると考えると述べた。中沢信午氏は菌類は植物なりや否やといっても *Volvox* のようなものはカイメン動物的ではないかと発言あり印東弘玄氏は藻類菌類は植物であり、とにかく植物側からは植物の仲間にとり入れるべきだとした。佐藤重平氏の Moreau 氏の分類は多源説というのが図によればむしろ単元説ではないかとの質問もでた。

この(3)(4)シンポジウムは出席者として 60 名を予定したが 200 名近くの参加者があり、その点では盛大であつた。たゞ問題が大きな範囲であるため、text を刷つて用意したにかゝらず時間が少なく、このためお互いの話しあいが深まるどころでやめなければならなかつた。これで参加者が納得いくほど話すことができずいいこともいえないうちに終り「腹ふくるるわざ」であつた。しかし問題となる点や、人々の考え方などわかり、問題に関心を持つようになったりしたこと、植物学会での分類学関係のシンポジウム最初の試みであつたことなどを考えれば有効であつたように思われる。テキストの準備までしていただき多くの努力をはらわれた話題提供者に対しまして熱心にきいて下さった参加者に感謝し、将来は問題点をしばって早く学会員にも知らせ、話しあいに充分な時間をとりたいと思う。

(3, 4 シンポジウム世話役 木村陽二郎記)

エクスカーション

都内見学

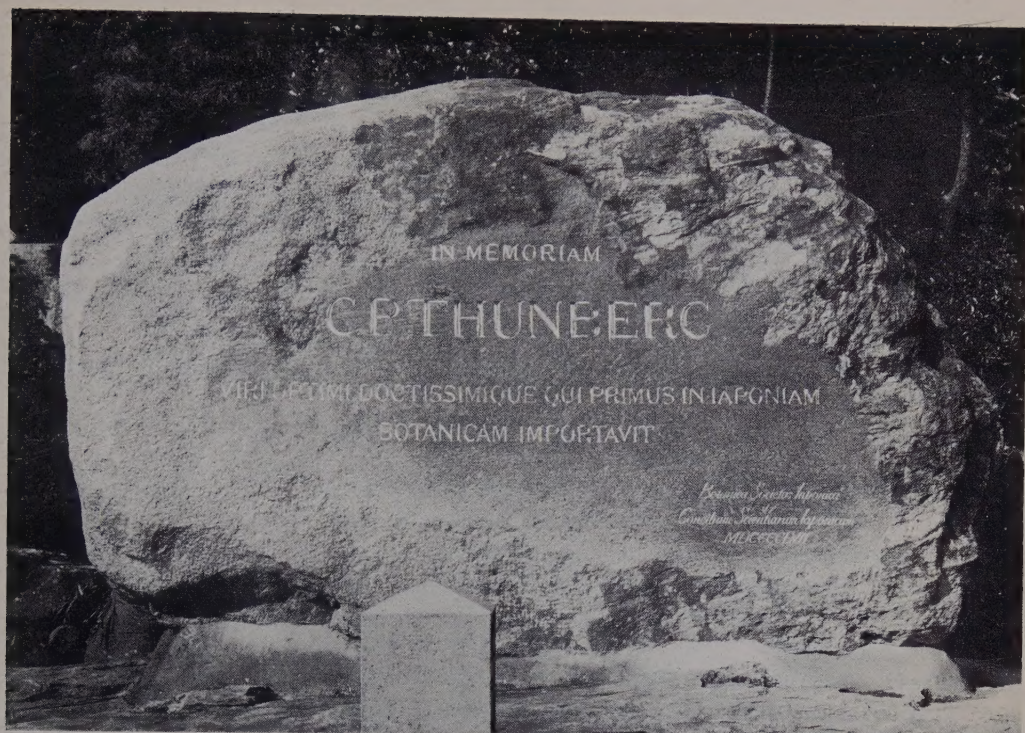
エクスカーションに都内見学を希望されたウオ

カー、鄭氏を含む会員 58 名は 15 日午後 1 時 30 分東大教養学部をバスにて出発、明治神宮、神宮外苑、靖国神社、後楽園等の説明をガイド嬢より聞きつつ西ヶ原の農業技術研究所に向う。同研究所では相見・村上両氏の案内で圃場、ポット栽培、アイソトープビルディング、風洞、定温試験室などを見学させて戴き、次に上野、浅草を通して吾妻橋のアサヒビール工場見学、ビールのできる過程を見学した後、工場側の好意により歓待を受け、「ビールむかしむかし」という色彩映画を見せて戴いた。夕闇迫る吾妻橋を後に日本橋、銀座、有楽町、東京駅と、楽しく有意義な都内見学を終った。この紙上をお借りして忙しい折に説明をして下さった農技研の研究員の皆様及びアサヒビール工場の皆様に厚く御礼申し上げます。

伊豆大島エクスカーション

10 月 15 日午後 10 時に竹芝棧橋出帆、参加会員 36 名。船は橘丸、特別に皆 2 等船室に入れた。16 日午前 4 時半に大島岡田港着、バスで大島観光ホテルへ行き休憩、朝食をとる。此の間に島第一の民俗学者白井潮路氏の興味深い話がある。7 時過ぎ再びバスにて三原山御神火茶屋に向い、此の間に島北部の地形展望や植物採集などを行い、9 時前に到着。昭和 26 年噴出の熔岩上を歩いて中央火口丘に登り、内部の活動状況を見る。11 時に引き返して御神火茶屋で昼食、バスで下る組と植物を観察しつつ歩いて行く組とに分れ、夕刻までに元町柳川館に落ち合う。全員揃っての夕食も楽しいものであつたが、何よりも 16 日が快晴に恵まれたのは幸いであつた。17 日は西風で雨、然し午後 3 時に岡田港を出帆するまでにはやんでおり、7 時半竹芝棧橋に帰着、解散。

今回のエクスカーションには教育見学会理事長西垣正雄氏の並々ならぬ御配慮があり、記して感謝の意を表したい。



ツェンペリー生誕二百年記念碑の設立について

Carl Peter Thunberg が、当時幕府から加えられた制約にかかわらず、多くの日本植物を集め、これを研究して新しく命名し、また既知のものにあてたことは、会員諸氏のすでに知られるところである。昭和 28 年 3 月 25 日発行のツェンペリー研究資料(日本学術会議、日本植物学会編)にはツェンペリーについて各般にわたって多彩の記載があるので、ついてみられることを希望する。

ツェンペリーの誕生日は 1743 年 11 月 11 日である。200 年にあたる 1943 年には、本国スウェーデンでは盛大な記念式典がおこなわれたが、日本では戦争中であつたため、みおくられてゐた。1953 年になっておくれればせながら記念の式をあげることがリンネ学会、日本学術会議、日本植物学会の主催できまり、東京と長崎とでそれぞれ 10 月 13 日、11 月 3 日に展示会と講演会とがおこなわれた。当時すでにツェンペリーの記念碑を長崎市にたてることが予定されており、その碑文が当時の日本植物学会長の小倉謙氏から田川市長におくられたのである。

しかし、費用の点から記念碑の建立はのびのび

となつてゐたが、ようやく長崎県と長崎市とから 25 万円の支出が可能になり、本年夏ごろから本格的な準備をはじめ、11 月に入つて碑の建立もその周囲の整理も終つたので、誕生日である本年の 11 月 11 日を期して、除幕式をおこなつた。碑は長崎公園へ入る坂道をすこしのぼつたところにたてられ、長崎市郊外の山腹からはこんだ石の面をいくらかけずり、これに写真で見られるように、
 “In memoriam C. P. Thunberg viri optimi doctissimique qui primus in japoniam botanicam importavit” という碑文とそれにそえて下にイタリックで日本植物学会、日本学術会議とはつてある。裏には日本語でややくわしくツェンペリー頌徳の文をはつてある。ラテン語の碑文は東北大学教授木村有香氏が苦心に苦心をかさねてつくられまた書かれたもので、裏の文章は北海道大学教授で日本学術会議植物学研究連絡委員会委員長の松浦一氏が原文をつくれ、木村氏と服部とが添削してつくつた。これにつかつた漢字は当用漢字を主とし、かなづかいはいは当用かなづかいによつたのである。

11 月 11 日はその前後が快晴であったのにあいにく雨がふり、そのため記念式典は長崎図書館の一室でおこない、除幕は木村氏がおこない、ツェンベリーの命名したサザンカの満開の枝をささげた。長崎市では長崎大学医学部開学 100 年祭、ボンベ百年祭、大学教授連合九州大会、原子爆弾影響調査委員会、出島オランダ屋敷復元式などがほとんど同時にひらかれ、学会知名の人たちがかなり多く長崎にこられたが、ツェンベリー記念碑除幕の式にはそれでも約 50 人の参列者があり、ささやかではあったが、意義ある会であった。参

列者には特別につくれたサザンカの花をかたどった紅白の砂糖菓子がおくられた。

日本学術会議を代表して松浦氏、碑文撰定者の木村氏、日本植物学会長としての服部が参列した。この碑の建立には、費用、敷地の点で長崎県、長崎市の知事、市長はじめ当路の方々が非常な好意をよせられ、また長崎大学教授戸山三郎氏は直接の建立準備の責任の衝にあられた、たいへんな努力をかたむけられた。これらの方々には日本植物学会として深く感謝するものである。

日本植物学会長 服部静夫

本 会 記 事

今回、名誉、外国通信会員に推薦された外国人の住所は次の通りです。

J. Bonner: California Institute of Technology, Pasadena 4, Calif., U.S.A.

E. Bünning: Botanisches Institut, Tübingen, Germany.

R. W. Chaney: Department of Paleontology, University of California, Berkeley, 4, Calif., U.S.A.

H. St. John: Department of Botany, University of Hawaii, Honolulu 14, Hawaii.

羅 宗洛: 中華人民共和国, 上海, 岳陽路, 中国科学院植物生理研究所

W. Ruhland: Unterdeufstetten, Schloß, ü. Carlsruhe, Württemberg, Germany.

K. V. Thimann: The Biological Laboratories, Harvard University, Cambridge, Mass., U.S.A.

E. R. Fosberg: 212 Holmes Run Rd., Falls Church, Va., U.S.A.

B. Lindquist: Botanic Gardens, Göteborg, Sweden.

郑 万鈞: 中華人民共和国, 南京, 林学院

H. Ullrich: Institut für Landwirtschaftliche Botanik, Bonn, Germany.

支 部 通 信

關 東 支 部

32 年度支部大会 (4 月 7 日, 於都立大・理)
加崎英男: フラスコモ等節類 (*Anarthrodactylae*) の一新種について。川崎次男: トラノオシダ (*Asplenium*) 数種の配偶体とその考察。福永公平: ムラサキツユクサの花弁細胞の増殖と針状結晶の消長について。鳥山英雄: オジギソウの種子に関する形態学的所見。高橋基生・渡辺庄美: 根系呼吸と遺伝 (第一報)。高橋基生: 切断根系の養分呼吸並びに呼吸の不自然性 (第二報)。特別講演: 木村陽二郎: 単子葉植物の体系と系統。長谷栄二: 緑藻クロレラの硫黄代謝について。相馬悌介: 輪藻植物の節間細胞の構造と原形質流動について。中山弘美・井上行雄: *Streptomyces griseus* の物質代謝, III 凍結乾燥菌によるアミノ酸の酸化。橋本徹・倉石晋: ギベレリンによる茎及び葉の生長促進について。薄井宏: 日本竹笹類のプロファイルについて。

6 月例会 (6 月 22 日, 於東大理植) 石川 辰夫: 突然変異の機構についての考察。鈴木静夫: ミズカビ科の遊走子。

9 月例会 (9 月 28 日, 於東大理植) 寺川 博典: ヒラタケの形態形成と核の行動。酒井文三: アゼトウナ自然雑種群退色反応による核型分析。

11 月例会 (11 月 16 日, 於東大理植) 中沢敬止: 植物のナイアシンについて。土屋工: オオムギに見出された新しい型の trisomic および tetrasomic について。

本会名誉会員郡場寛氏は 1957 年 12 月 15 日 零時 30 分 弘前に おいて 死去 されました。

ここに報告し、深甚なる哀悼の意を表します。

日 本 植 物 学 会

